

## Servo Ventilator 300/300A

### Service Manual



# Important

## General

- Unless stated otherwise, the information in this Service Manual is valid for:
  - Servo Ventilator 300 (SV 300)
  - Servo Ventilator 300A (SV 300A).
- The documentation for the Servo Ventilator 300/300A consists of:
  - Operating Manual
  - Service Manual
  - Circuit Diagram
  - Spare Parts Catalogue
  - Reference Manual, Computer Interface
- The Operating Manual is an indispensable complement to the Service Manual for proper servicing.
- In addition to the Important information given here and in the related documents, always pay attention to applicable local and national regulations.
- Responsibility for the safe functioning of the equipment reverts to the owner or user in all cases in which service or repair has been done by a non-professional or by persons who are not employed by or authorized by Siemens, and when the equipment is used for other than its intended purpose.
- Data on internal pressures in the Servo Ventilator 300/300A are given in Pa (bar). Airway pressures are given in cm H<sub>2</sub>O.

1 hPa = 1 mbar	1 mbar = 1 hPa
1 kPa = 10 mbar	1 mbar = 0.1 kPa
1 kPa = 0.01 bar	1 bar = 100 kPa
1 kPa ≈ 10 cm H <sub>2</sub> O	1 cm H <sub>2</sub> O ≈ 0.1 kPa
1 kPa ≈ 0.01 at	1 at ≈ 100 kPa
1 kPa ≈ 0.01 kgf/cm <sup>2</sup>	1 kgf/cm <sup>2</sup> ≈ 100 kPa
1 kPa ≈ 0.01 kp/cm <sup>2</sup>	1 kp/cm <sup>2</sup> ≈ 100 kPa
1 kPa ≈ 0.145 psi	1 psi ≈ 6.9 kPa

## Calibration and functional check

- After any service intervention in Servo Ventilator 300/300A, perform a Calibration and Functional check according to instructions in the Operating Manual.

## Hazard notices

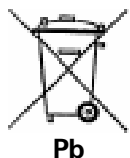
- Before disassembling or assembling the Servo Ventilator 300/300A, make sure that the:
  - Gas supply is disconnected.
  - Mains power cable is disconnected.
  - Mode selector is set to Ventilator off. If the mode selector is set in any other position, the internal battery will supply power to the PC boards.
  - The back-up batteries are disconnected when the power section is open.
  - All gas conveying parts are cleaned according to instructions in the Operating Manual.

## Service

- When working with ESD sensitive components, always use a grounded wrist band and a grounded work surface. Adequate service tools must always be used.
- Some parts in the Servo Ventilator 300/300A are comprised by a spare parts exchange system. Your local Siemens representative supplies factory calibrated and tested exchange parts as well as other spare parts indicated in the spare parts catalogue.


## Important

- The Servo Ventilator 300/300A must be serviced at regular intervals by specially trained personnel. The service intervals, 1000 and 3000 operating hours, are described in the Operating Manual. Any maintenance must be noted in a log book provided for that purpose in accordance with national regulations. We recommend that service is done as a part of a service contract with Siemens.
- A 1000 hour overhaul must be performed after 1000 hours of operation or, at the latest, every six months. In addition, the ventilator shall undergo a technical safety check (Function check) twice a year, at six months intervals or according to national regulations.
- A 3000 hour overhaul must be performed after every 3000 hours of operation or, at the latest, once every year.
- The internal batteries shall be replaced every 3 years according to instructions in this Service Manual. The stated battery back-up time, approx. 30 minutes, can be guaranteed only if they are used as power supply back-up at mains failure.
- The battery on PC 1587 COMPUTER INTERFACE shall be replaced every 5 years according to instructions in this Service Manual.



- Old non-functioning batteries and O<sub>2</sub> cells must be returned to the place of purchase or to a place where they can be disposed of properly. Batteries and O<sub>2</sub> cells must not be disposed of with ordinary waste.

### To the responsible service personnel

- The contents of this document are not binding. If any significant difference is found between the product and this document, please contact Siemens for further information.
- We reserve the right to modify products without amending this document or advising the user.
- Only Siemens authorized personnel shall be permitted to service or repair the Servo Ventilator 300/300A. Only Siemens-Elema exchange parts or genuine spare parts must be used. PC boards (spare or exchange parts) must always be kept in a package for sensitive electronic devices.
- Siemens will not otherwise assume responsibility for the materials used, the work performed or any possible consequences of same.
-  The device complies with the requirements of the Medical Device Directive 93/42/EEC.

## Notes

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## Notes

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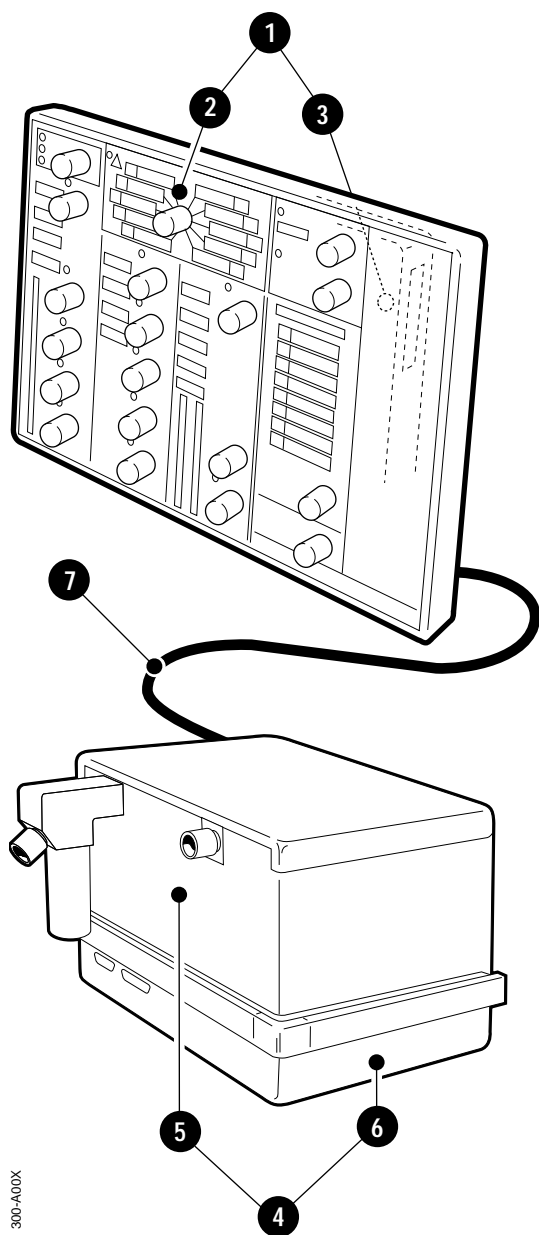
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## Main units

The Servo Ventilator 300 can be divided into two main units:

- Control unit (1). The control unit consists of the panel section (2) and the control section (3).
- Patient unit (4). The patient unit consists of the pneumatic section (5) and the power section (6).

The patient unit and the control unit are connected to each other with the inter-connection cable (7).

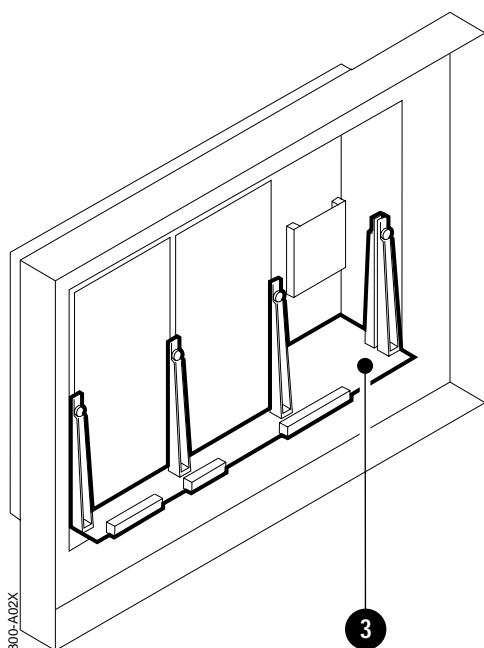
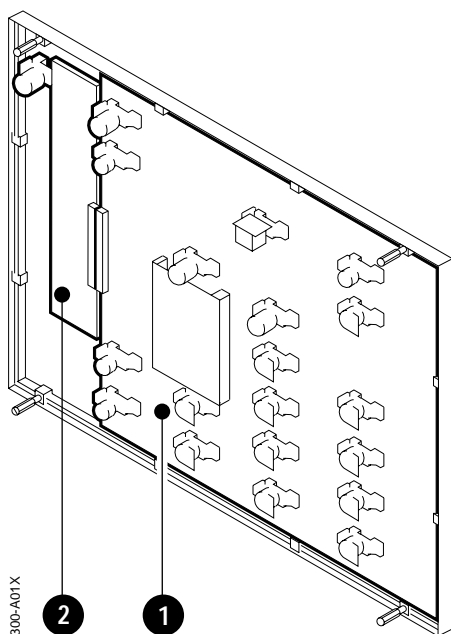


## Control unit

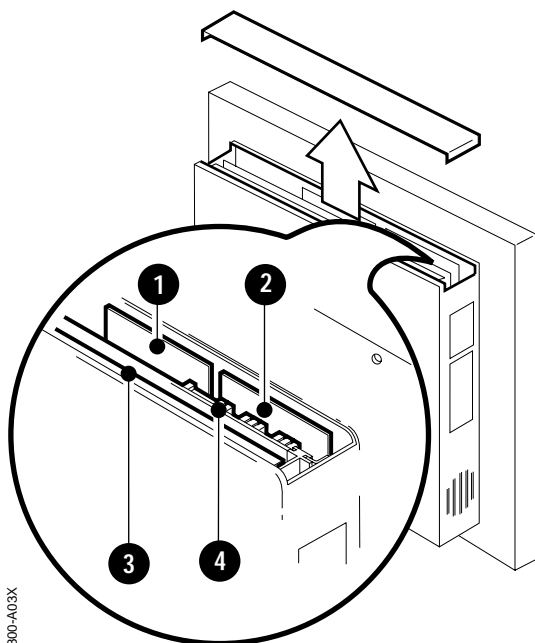
The control unit consists of the control section which is a housing with a number of PC boards. The panel section, attached to the control section, is the other part of the control unit.

With the panel section removed from the control section, the following parts are accessible:

- Front panel controls
- PC 1614 PANEL INTERFACE (1) with PC 1588 MICROPROCESSOR MODULE and PAN-PROM
- PC 1745 AUTOMODE PANEL INTERFACE (2). Only for SV 300A.
- PC 1617 CONTROL INTERCONNECTION (3).



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All PC boards in the control section (except PC 1617 mentioned above) are accessible when the control section cover is removed. These PC boards are:

- PC 1605 REFERENCE & TIMING (1) with PC 1588 MICROPROCESSOR MODULE and REF-PROM
- PC 1616 INSPIRATORY CONTROL (2) with PC 1588 MICROPROCESSOR MODULE and MIX-PROM
- PC board (3);
  - PC 1665 COMPUTER INTERFACE DUMMY *or*
  - Optional PC 1587 COMPUTER INTERFACE (3) with COM-PROM
- PC 1608 MONITORING (4) with PC 1588 MICROPROCESSOR MODULE and MON-PROM.

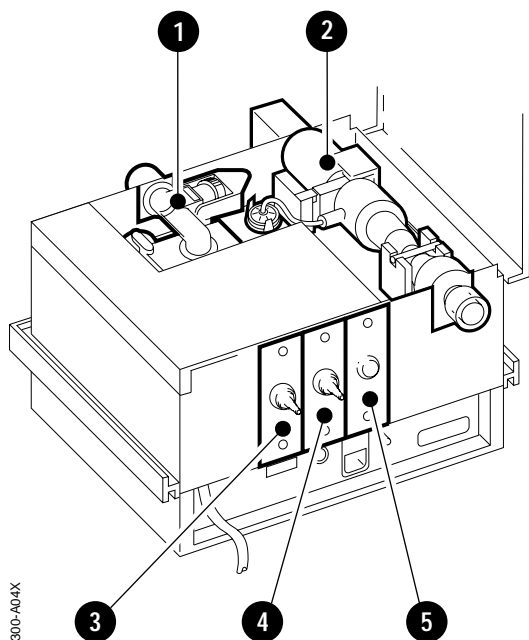
## Patient unit

The upper part of the patient unit is the pneumatic section. Under the lid of the pneumatic section you will find the:

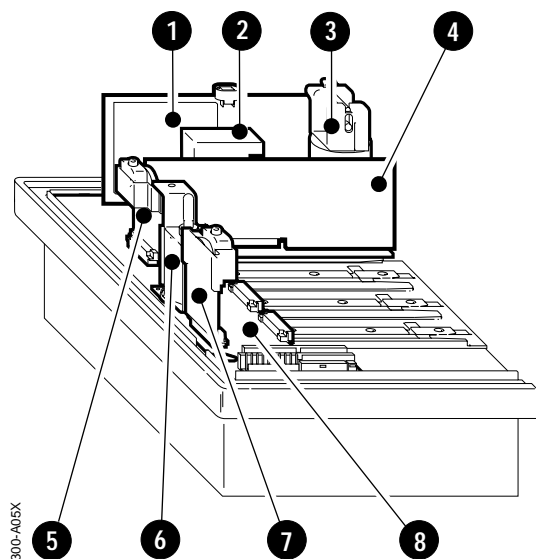
- Inspiratory channel (1) including O<sub>2</sub> cell
- Expiratory channel (2) including flow transducer.

The inspiratory valves (gas modules) are located in three different slots in the pneumatic section:

- Inspiratory valve unit – AIR (3)
- Inspiratory valve unit – O<sub>2</sub> (4)
- Inspiratory valve unit – Optional (5).  
The valve dummy in the third slot can be replaced by an inspiratory valve for administration of e. g. NO gas or by equipment for nebulizing drugs (Servo Ultra Nebulizer 345). These products are described in separate documents.

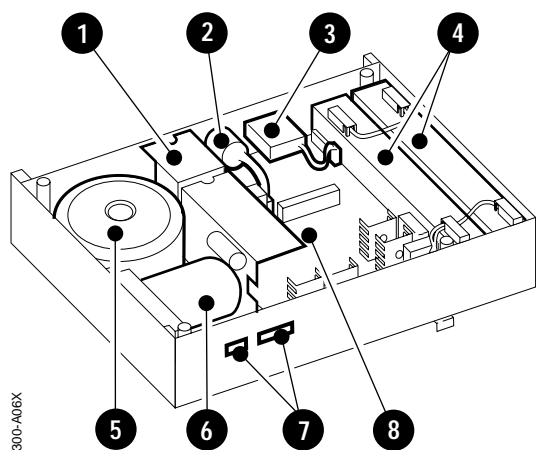


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When the pneumatic section casing and the cover plate is removed, the following parts are accessible:

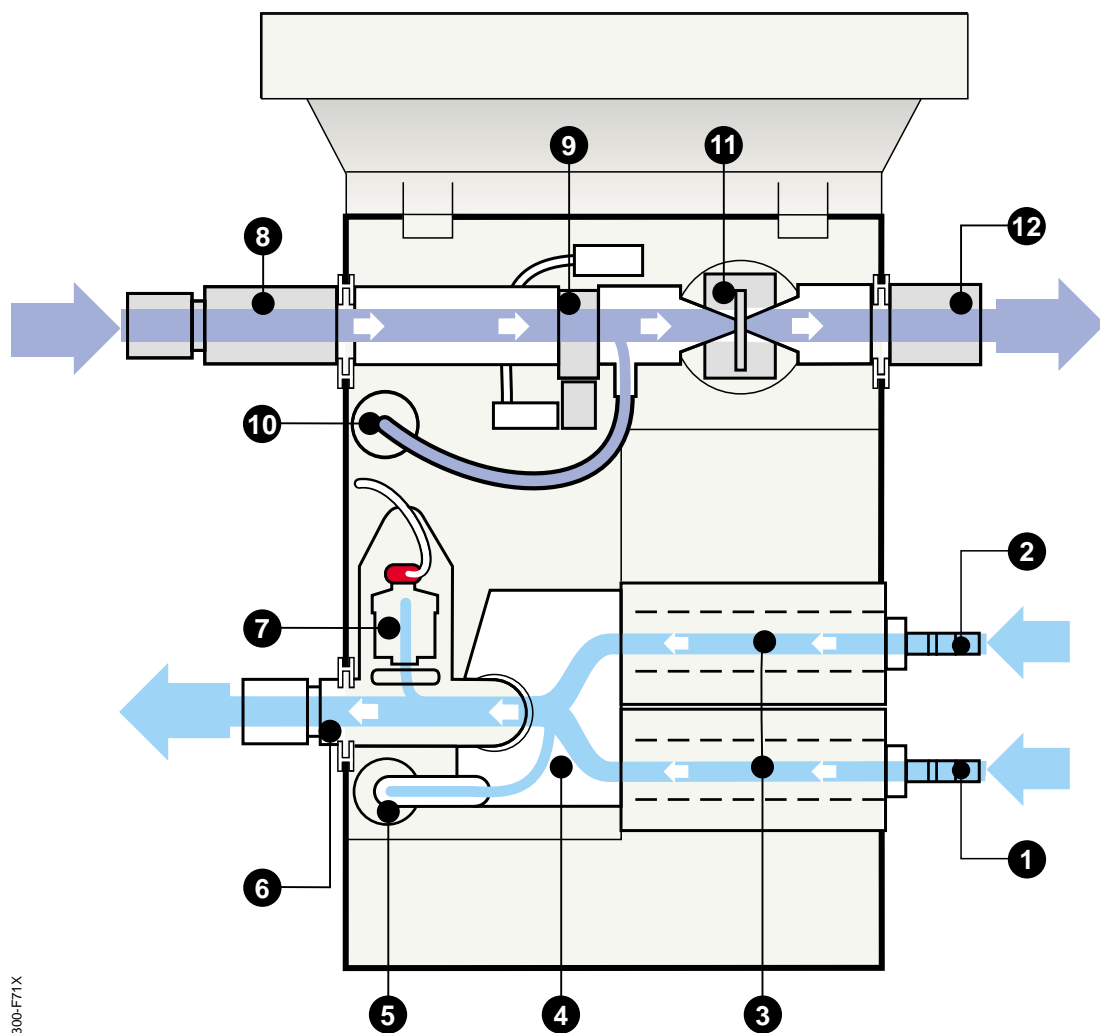
- PC 1615 EXPIRATORY FLOW LINEARIZATION (1) with PC 1588 MICROPROCESSOR MODULE and LIN-PROM
- Housing (2) containing PC 1585 CURRENT CONTROL and PC 1586 CURRENT POWER
- Expiratory valve (3)
- PC 1622 VALVE CONTROL (4)
- PC 1611 EXPIRATORY PRESSURE AMPLIFIER (5)
- Safety valve (6) with PC 1613 SAFETY VALVE DRIVER
- PC 1611 INSPIRATORY PRESSURE AMPLIFIER (7)
- PC 1607 PNEUMATIC INTERCONNECTION (8).



The lower part of the patient unit is the power section. With the pneumatic section separated from the power section the following parts are accessible:

- Mains power inlet (1)
- External battery inlet (2)
- Operating time meter (3)
- Batteries (4)
- Transformer (5)
- Capacitor (6)
- Auxiliary equipment outputs (7)
- PC 1618 POWER SUPPLY (8).

## 1



## Gas flow through the patient unit

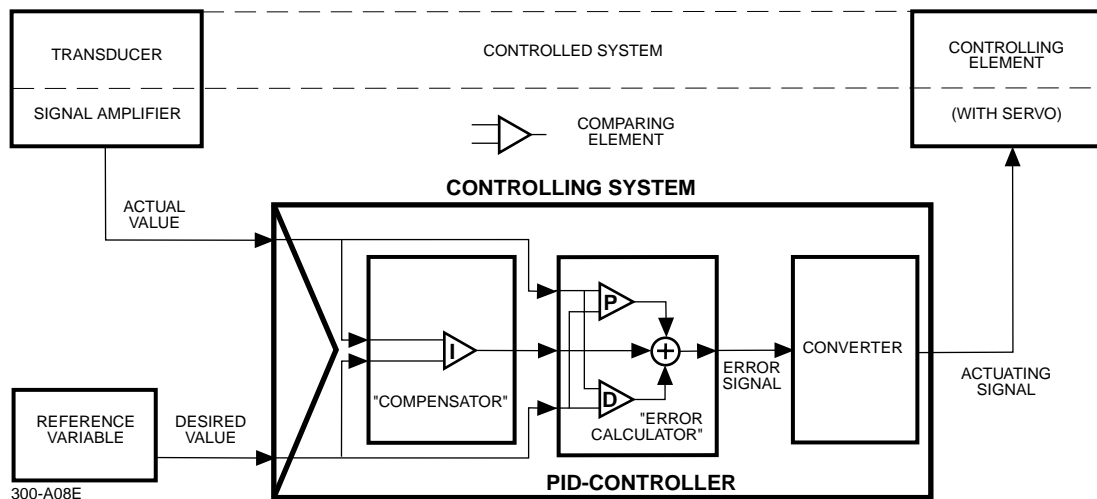
### Inspiratory flow

1. Gas inlet for air. The connected air must have a pressure between 200 and 650 kPa (2 and 6.5 bar).
2. Gas inlet for O<sub>2</sub>. The connected O<sub>2</sub> must have a pressure between 200 and 650 kPa (2 and 6.5 bar).
3. The flow of the gas delivered to the patient system is regulated by the inspiratory valves. There is one inspiratory valve unit (gas module) for each gas. The inspiratory valves are regulated by a feedback control system that is described in this chapter.
4. The gases are mixed in the inspiratory mixing part.
5. The pressure of the mixed gas delivered to the patient (inspiratory pressure) is measured by the inspiratory pressure transducer. The transducer is protected by a bacteria filter.
6. The inspiratory pipe leads the mixed gas from the inspiratory mixing part to the patient system. The inspiratory pipe also contains the safety valve, a holder for the O<sub>2</sub> cell and the inspiratory outlet. The springloaded safety valve will open in case of a power failure and/or if the inspiratory pressure exceeds 120 cm H<sub>2</sub>O. It will also open if the set upper pressure limit is exceeded by 5 cm H<sub>2</sub>O.
7. The oxygen concentration inside the inspiratory pipe is measured by the O<sub>2</sub> cell. The O<sub>2</sub> cell is protected by a bacteria filter.

### Expiratory flow

8. The patient system's expiratory gas tube is connected at the expiratory inlet. The expiratory inlet also contains a moisture trap.
9. The gas flow through the expiratory channel is measured by the expiratory flow transducer. Patient trigger efforts, indicated by a decreased continuous flow, are sensed by this expiratory flow transducer.
10. The expiratory pressure is measured by the expiratory pressure transducer. The transducer is protected by a bacteria filter. Patient trigger efforts, indicated by a pressure drop, are sensed by this expiratory pressure transducer.
11. The pressure of the gas (PEEP pressure) in the patient system is regulated by the expiratory valve. The expiratory valve is regulated by a feedback control system that is described in this chapter.
12. The gas from the patient system leaves the ventilator via this expiratory outlet. The outlet contains a non-return valve which is a part of the patient triggering system.

## Feedback control system – General



Any CONTROLLING SYSTEM may comprise one single CONTROLLER or, for instance, a cascade of more than one CONTROLLER. Compensating elements may also be added.



CONTROLLER symbol used in this chapter.

In each CONTROLLER, the actual value normally from a TRANSDUCER in the CONTROLLED SYSTEM is compared to the desired value = REFERENCE VARIABLE. The difference between these two input values results at the output of the controlling system in an ACTUATING SIGNAL.

Each CONTROLLER may comprise some combination of the following parts:

- Proportional action, P
- Integral action, I
- Derivative action, D.

P-action gives a continuous basic positioning.

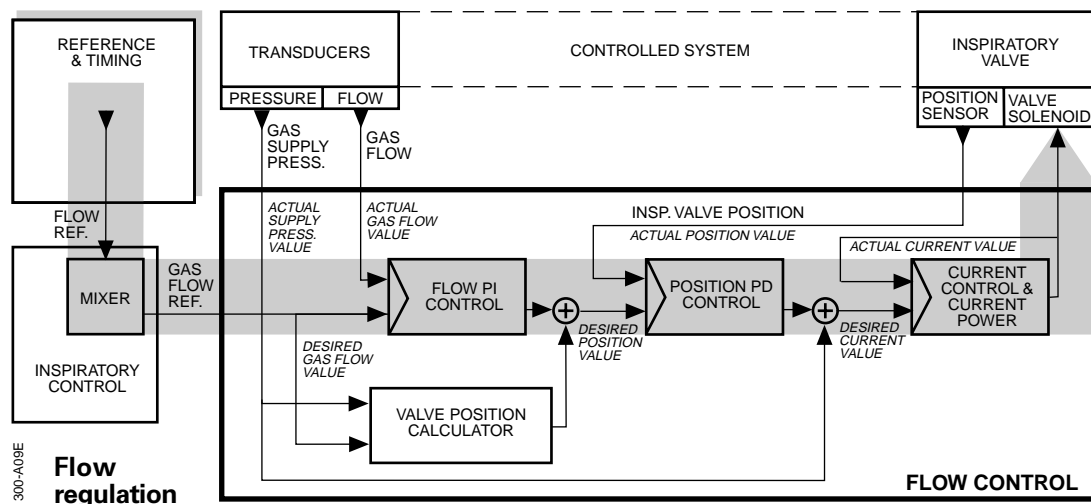
I-action gives a slowly varying positioning compensation for small long time deviation.

D-action gives a speed-up positioning reaction at (fast) changes.

The signals from these parts (from the parts used in the actual combination) are added. The sum is the total ERROR SIGNAL which may be converted before use as an ACTUATING SIGNAL.

Each CONTROLLING ELEMENT (in the ventilator: inspiratory valves and expiratory valve) is positioned by the ACTUATING SIGNAL from its controlling system. Feedback control, which is synonymous with regulation, results in the controlled valve being moved into such a position that the ACTUAL VALUE is kept equal to the DESIRED VALUE independently of disturbance variables like changes in the airway resistance or lung compliance.

## Inspiratory feedback control system



The inspiratory feedback control system uses cascade control with a number of controllers and compensating elements.

### Flow regulation

Inspiratory flow regulation occurs during inspiration time in the modes Volume Control and SIMV (Vol. Contr.) and during expiration time in all modes.

When flow regulation is used, the shadowed main forward path comprises the following:

- The microprocessor module in the block **MODE CPU** in the main block **REFERENCE & TIMING** generates a **FLOW REF.** signal.
- The block **MIXER**, in the main block **INSPIRATORY CONTROL**, splits the **FLOW REF.** signal into one **GAS FLOW REF.** signal for each inspiratory valve (**AIR FLOW REF.** and **O<sub>2</sub> FLOW REF.**). Each **GAS FLOW REF.** signal is used (after a minor correction within  $\pm 5\%$ ) as **DESIRED GAS FLOW VALUE** (reference variable).
- **ACTUAL GAS FLOW VALUE** is generated by signal converters (**FLOW**) using signals from measuring **TRANSDUCERS**.
- The actuating signal from the **FLOW PI CONTROL** results in the **DESIRED POSITION VALUE** (reference variable) for the **POSITION PD CONTROL**. The **POSITION SENSOR** at the **INSPIRATORY VALVE** generates a valve position signal which is used as the **ACTUAL POSITION VALUE** in the **POSITION PD CONTROL**.
- The actuating signal from the **POSITION PD CONTROL** results in the **DESIRED CURRENT VALUE** (reference variable) for the **CURRENT CONTROL & CURRENT POWER**.
- The **ACTUAL CURRENT VALUE** is an internal feedback signal used in the **CURRENT CONTROL** block.
- The actuating signal from the output stage of the **CURRENT CONTROL & CURRENT POWER** is a voltage pulse train with pulse width modulation used to actuate the **INSPIRATORY VALVE SOLENOID** which generates a certain opening of the **INSPIRATORY VALVE**.

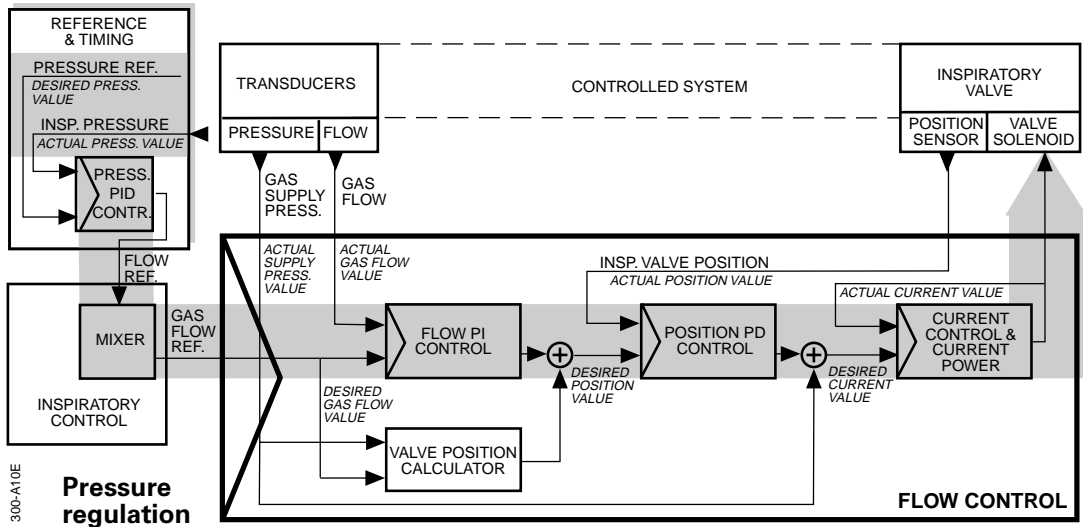
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In addition to the main forward path, compensating elements are added as described in both inspiratory feedback control system pictures. The compensating elements in this system works as follows:

- Using the input information of ACTUAL SUPPLY PRESSURE VALUE and DESIRED GAS FLOW VALUE the VALVE POSITION CALCULATOR directly generates a rough approximate POSITION VALUE which helps to obtain the desired position within minimum time.
- The input information of ACTUAL SUPPLY PRESSURE VALUE is used (inverted and adequately scaled) to create one small part of the DESIRED CURRENT VALUE. This small part of the DESIRED CURRENT VALUE will – in combination with the opening force of the INSPIRATORY VALVE implied by the pressure of the supplied gas – help to balance the closing force on the INSPIRATORY VALVE implied by the mechanical spring inside the VALVE SOLENOID even in closed position of the INSPIRATORY VALVE.



## Inspiratory feedback control system (cont'd)



### Pressure regulation

Inspiratory pressure regulation is used only during inspiration time in all modes except when flow regulation is used as mentioned previously.

When PRESSURE regulation is used, the shadowed main forward path includes the PRESSURE PID CONTROL block in the REFERENCE & TIMING main block:

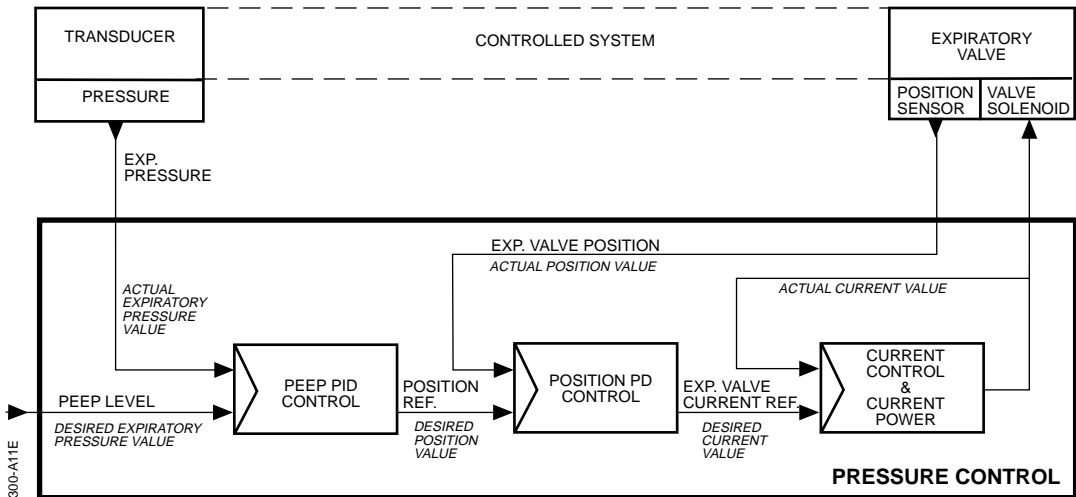
- DESIRED VALUE is the PRESSURE REFERENCE signal from (the microprocessor module MODE CPU within) the main block REFERENCE & TIMING

- ACTUAL VALUE is the INSP. PRESSURE signal from the INSPIRATORY PRESSURE TRANSDUCER
- The actuating signal from the PRESSURE PID CONTROL block is used as a FLOW REFERENCE signal going to the MIXER.

The rest of the controlling system, including compensating elements, is the same as in flow regulation.

## 1

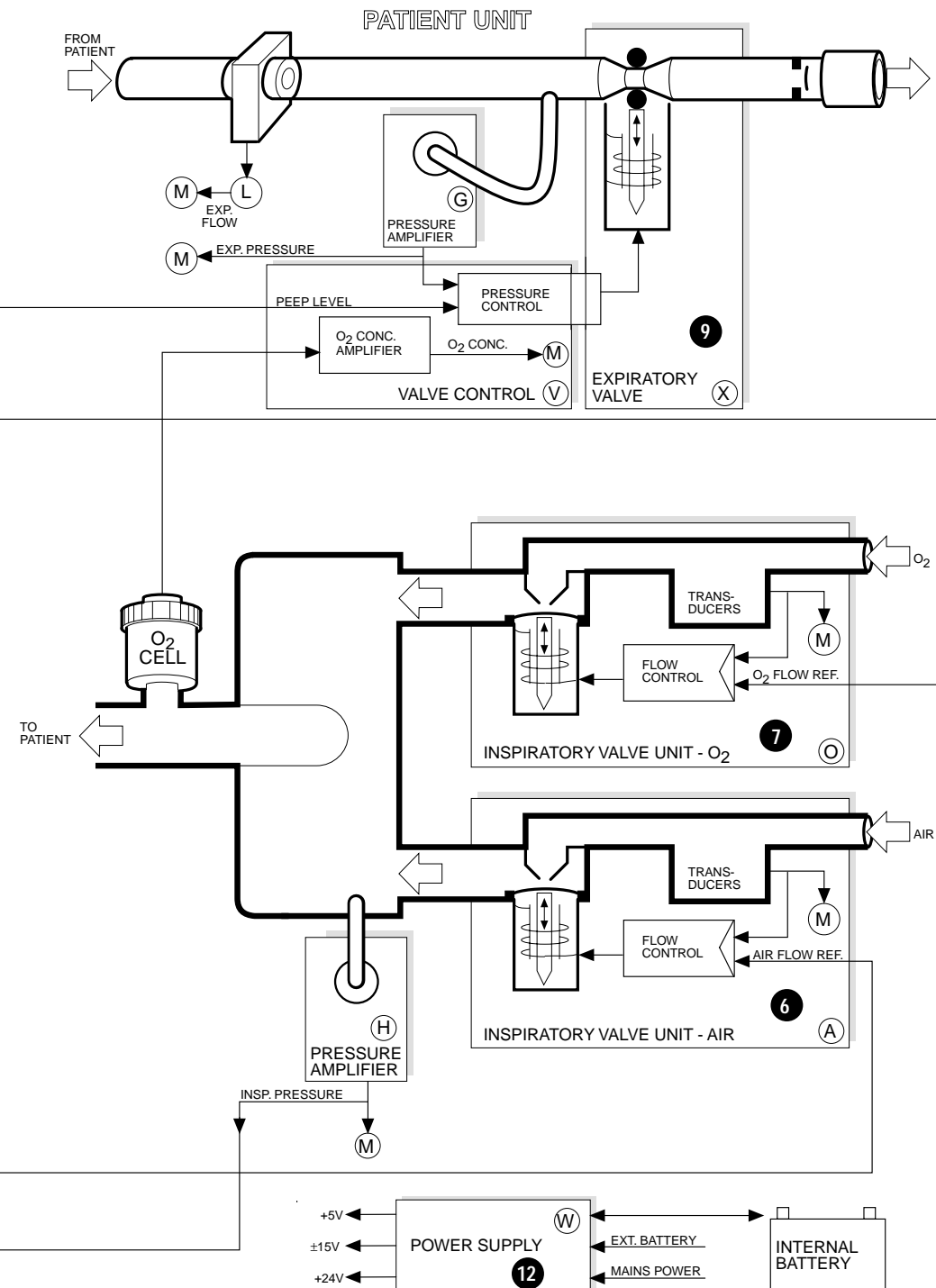
## Expiratory feedback control system



The expiratory feedback control system uses cascade control. It is active only during expiration time in all modes. It applies PRESSURE regulation.

- **DESIRED VALUE** is the PEEP LEVEL signal from the PANEL SECTION (according to front panel setting)
- **ACTUAL VALUE** is the EXP. PRESSURE signal from the expiratory PRESSURE TRANSDUCER.
- The actuating signal from the PEEP PID CONTROL block is the POSITION REF. signal used as DESIRED VALUE for the POSITION PD CONTROL.
- **ACTUAL VALUE** is the EXP. VALVE POSITION signal from the POSITION SENSOR in the EXPIRATORY VALVE.
- The actuating signal from the POSITION PD CONTROL block is the EXP. VALVE CURRENT REF. signal used as DESIRED VALUE for the CURRENT CONTROL & CURRENT POWER.
- The **ACTUAL CURRENT VALUE** is an internal feedback signal used in the CURRENT CONTROL block.
- The actuating signal from the output stage of the CURRENT CONTROL & CURRENT POWER is a pulse train with pulse width modulation used to actuate the EXPIRATORY VALVE SOLENOID which generates a certain opening of the EXPIRATORY VALVE.

The diagram illustrates the control unit's architecture. At the top, the **CONTROL UNIT** is divided into two main sections: **COMPUTER INTERFACE (11)** and **MONITORING (10)**. The **COMPUTER INTERFACE** receives **EXTERNAL CONTROL SIGNALS**, **INPUT FROM SV 300 INTERNAL MICROPROCESSORS**, and **INPUT SIGNALS**. It outputs **EXTERNAL OUTPUT SIGNALS** and **CONTROL SIGNALS**. The **MONITORING** section receives **INPUT SIGNALS** and outputs **C**, **P**, and **T** signals. Below these, the **REFERENCE & TIMING (T)** and **INSPIRATORY CONTROL (I)** modules are shown. The **REFERENCE & TIMING** module includes a **PRESSURE PID CONTROL** and a **PRESSURE REF.** input. The **INSPIRATORY CONTROL** module includes a **SELECTION OF PRESSURE OR FLOW REGULATION** and a **FLOW REF.** input. Both modules output **FLOW REF.** signals. These signals, along with **INSP. PRESSURE**, are fed into a **MIXER** module. The **MIXER** module outputs **O<sub>2</sub> FLOW REF.** and **AIR FLOW REF.** signals. The diagram also shows a physical control panel with various buttons and knobs, with numbered callouts (1, 2, 3, 4, 5, 8) indicating specific components. A dashed line indicates a connection between the **MONITORING** section and the physical panel.



## Inspiratory regulation

1. Choice between pressure regulation and flow regulation during inspiration is made by the **MODE CPU** dependent on the Mode selection.
2. Main parameters used for the flow level during inspiration when flow regulation is used.
3. Main parameters used for the pressure level during inspiration when pressure regulation is used.
4. Inspiration rise time setting determines the initial inspiration pattern. A successively increased flow/pressure level may be more comfortable for the patient.
5. The  $O_2$  concentration delivered to the patient depends on the setting of these  $O_2$  concentration control knobs.
6. **INSPIRATORY VALVE UNIT—AIR.**  
The control system is described in section "Inspiratory feedback control system" in this chapter.
7. **INSPIRATORY VALVE UNIT— $O_2$ .**  
The control system is described in section "Inspiratory feedback control system" in this chapter.

## Expiratory regulation

8. PEEP level setting is used as **DESIRED EXPIRATORY PRESSURE VALUE**. See section "Expiratory feedback control system" in this chapter.
9. **EXPIRATORY VALVE** interacts with the **VALVE CONTROL** board as described in section "Expiratory feedback control system" in this chapter.

## Monitoring

10. The **MONITORING** board monitors and generates certain displayed parameters. It also activates alarm functions.

## Computer interface

11. The optional **COMPUTER INTERFACE** board is used as input/output signal interface and includes functions for computer communication (RS-232). The PC board is equipped with the following connectors:
  - Master/Slave connection (N80)
  - Analog I/O terminal (N81)
  - Serial communication ports (N82/N83)
  - Analog input & Digital code port (N84).

## Power supply

12. The **POWER SUPPLY** board controls and distributes power to the different parts of the ventilator. The power source can be:
  - Mains power
  - External battery
  - Internal battery.

## 1

## 2. Description of functions

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## General

As described in chapter Introduction, the Servo Ventilator 300 can be divided into two *Main units*; Control unit and Patient unit. The two main units are connected to each other with the Interconnection cable.

For the purpose to describe all different functions in the Servo Ventilator 300, the two main units are further divided as follows:

*Main unit*

*Section*

*Main block*

*Functional block*

Example:

Control unit

Panel section

1 Front panel

1.1 Patient range selection

1.2 Airway pressure

etc.

2 Panel interface

2.1 Panel CPU including PAN-PROM functions

2.2 Parameter buffers

etc.

Functional descriptions of the *Main blocks* and *Functional blocks* can be found in this chapter. This functional description is based on and refers to the [Functional block diagram](#) that can be found as a fold out on the rear cover.

In this Description of functions, the words inspiratory and expiratory are used in the first place to indicate the *site* of a part (e g INSPIRATORY CHANNEL).

The words inspiration and expiration are used in the first place to indicate the corresponding *time* interval during ventilation (e g INSPIRATION TIME)



## Microprocessor module PC 1588

A MICROPROCESSOR MODULE, PC1588 (1), is included on each one of the following five PC boards:

- PC 1605 – REFERENCE & TIMING
- PC 1608 – MONITORING
- PC 1614 – PANEL INTERFACE
- PC 1615 – EXP. FLOW LINEARIZATION
- PC 1616 – INSPIRATORY CONTROL.

PC 1588 is mounted with its two rows of connectors (P65 and P66) into the corresponding connectors (HYB1) on the above mentioned PC boards.

PC 1588 is a programmable digital control block including:

- Microprocessor
- Analog – digital conversion
- Digital – analog conversion
- Digital I/O.

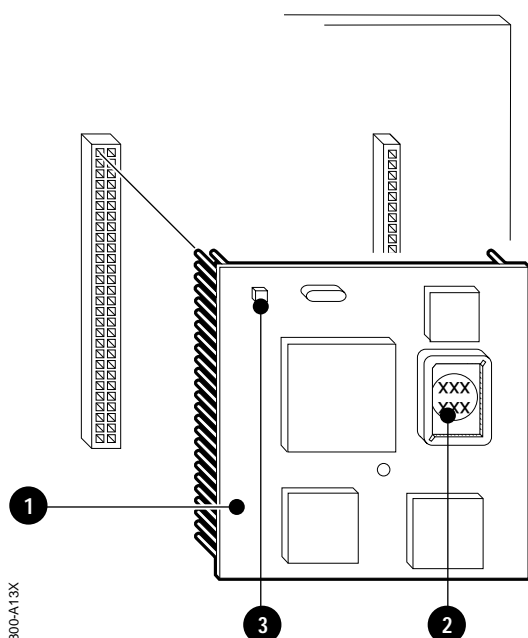
PC 1588 includes a green/red WATCHDOG LED D1 (3). The LED indications are as follows:

- Green LED: Microprocessor program is running.
- Red LED: Program error indication.
- LED not lit: Microprocessor program not running.

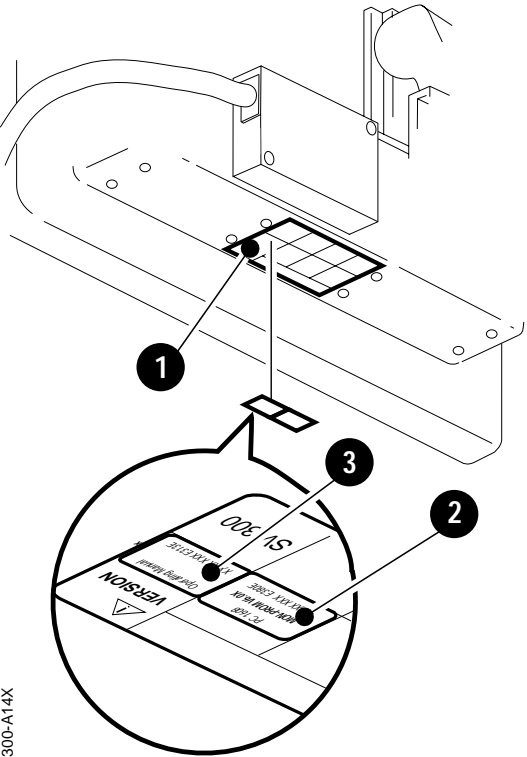
PC 1588 also includes an exchangeable program memory, PROM (2). The function of PC 1588 depends on this PROM which is different on the five different enumerated boards. The PROM functions are mentioned in the description of the following blocks:

- 2.1 Panel CPU (PAN-PROM)
- 4.1 Monitor/Alarm CPU (MON-PROM)
- 6.1 Mode CPU (REF-PROM)
- 7.1 Mixer CPU (MIX-PROM)
- 18.1 Linearizing CPU (LIN-PROM)

**Note** – The MICROPROCESSOR -block on PC 1587 – COMPUTER INTERFACE, includes two PROM modules (COM-PROM).  
PC 1588 is not used on PC 1587.



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## Version labels

A label (1) showing all PROM-versions included in the ventilator is attached to the control section. When replacing a PROM, attach the new label (2) that is delivered with the new PROM onto the old label on the control section.

Changing PROM-versions in the ventilator is used to add or change functions in the ventilator. For that reason, it may also be necessary to replace the Operating Manual in connection with PROM replacements. The Operating Manual, valid for the combination of PROMs used in the ventilator, is identified with a version number stated both on the manual and on the label (3). When replacing the Operating Manual with a new version of the manual, attach the new label (3) that is delivered with the new Operating Manual onto the old label on the control section.

Control unit – Panel section

The Panel section consists of the main blocks 1 – 2 which are described below.

1 Front panel

This main block contains the front panel film, in different language versions, and the various displays and controls with connection cables and their connectors.

The optional front panel function for SV 300A is described in section 1A AUTOMODE that can be found after 1.8 MODE SELECTION.

1.1 Patient range selection

For selection of one of three available patient ranges:

- 1 three-position selector. This switch generates selection information from two switch decks delivering one two bit code and corresponding two bit complementary code.
- 3 yellow indicator LEDs.

The following table indicates how Patient range selection affects some other parameters:

Parameter	Adult	Pediatric	Neonate	Unit
Apnea alarm – delay time	20	15	10	s
“ Bias flow” = Constant flow during expiration time	32 2	16 1	8 0.5	ml/s l/min
Max. inspiratory flow	3000 180	500 30	200 12	ml/s l/min
Max. (preset or measured) inspiratory or expiratory tidal volume	3999	399	39	ml
FLOW REF overrange limit	3.3	0.55	0.22	l/s
Expiratory minute volume alarm: Setting range for Upper alarm limit Setting range for Lower alarm limit * Lowest value for normal (digital) alarm * Lowest value for backup alarm	0 - 60 * - 40 0.3 0.2	0 - 60 * - 40 0.3 0.2	0 - 6 * - 40 0.06 0.05	l/min l/min l/min l/min
For Automode: Time duration since last patient trigger when Control/Support mode switches from Support mode to Control mode.	12	8	5	s

## 1.2 Airway pressure

For control and monitoring of AIRWAY PRESSURE parameters:

- 4 four-character LED displays.
- 1 double column LED bargraph.
- 5 potentiometer knobs:
  - Upper press. limit. Push button release function for one-way mechanical stops at approx. 60, 80 and 100 cm H<sub>2</sub>O.
  - Pressure Control Level above PEEP. Push button release function for one-way mechanical stops at approx. 30, 60 and 80 cm H<sub>2</sub>O.
  - Pressure Support Level above PEEP. Push button release function for one-way mechanical stops at approx. 30, 60 and 80 cm H<sub>2</sub>O.
  - PEEP. Push button release function for one-way mechanical stop at approx. 20 cm H<sub>2</sub>O.
  - Trigg. sensitivity Level below PEEP.
- 5 yellow indicator LEDs.

## 1.3 Respiratory pattern

For control and/or monitoring of respiratory pattern parameters:

- 4 four-character LED displays
- 5 potentiometer knobs:
  - CMV freq. b/min. This control is equipped with two parallel potentiometers – one for the control function and the other for the monitor/ alarm function.
  - Insp. time %. Push button release function for two-way mechanical stops at approx. 20, 50 and 70%.
  - Pause time %. Push button release function for one-way mechanical stop at approx. 20%.
  - Insp. rise time %. Push button release function for one-way mechanical stop at approx. 1%.
  - SIMV freq. b/min.
- 5 yellow indicator LEDs.

## 1.4 Volume

For control and/or monitoring of minute volume and tidal volume parameters:

- 2 four-character green LED displays. Showing information generated via 2.1 PANEL CPU.
- 3 four-character red LED displays. Showing information generated via 4.1 MONITOR/ALARM CPU.
- 2 fields of double column LED bargraph.
- 3 potentiometer knobs:
  - Volume
  - Upper alarm limit
  - Lower alarm limit.
- 3 yellow indicator LEDs.

## 1.5 O<sub>2</sub> concentration

For control and monitoring of O<sub>2</sub> concentration parameters:

- 1 four-character LED display. Showing information generated via 2.1 PANEL CPU.
- 1 potentiometer knob with push button release function for two-way mechanical stop at approx. 60 %. This control is equipped with two parallel potentiometers – one for the regulation function and the other for the monitor/alarm function.
- 1 non-locking, two-way selector for Oxygen breaths and for Start breath.
- 2 yellow indicator LEDs.

## 1.6 Alarms and messages

For the display of alarms and messages:

- 1 eight-character LED display. Showing information generated via 4.1 MONITOR/ALARM CPU.
- 8 different alarm fields each comprising:
  - 1 red indicator LED
  - 1 yellow indicator LED
  - 1 touch sensor
- 1 non-locking, two-way selector for Reset and for 2 min off. This information is handled by the main block 4 MONITORING.

## 1.7 Pause hold

For the control, via main block 6 REFERENCE & TIMING, of pause hold functions:

- 1 non-locking two-way selector for Insp. pause hold and for Exp. pause hold.

## 1.8 Mode selection

For the selection of Ventilation Modes and control of the Set Parameter Guide functions:

- 1 green Mains indicator LED
- 1 ten-position selector always supplied with high impedance 24 V. This switch generates selection information from two switch decks delivering complementary code via PC board (PC 1632). The mode Optional can not be selected.
- 10 different fields each comprising:
  - 1 yellow indicator LED
  - 1 touch sensor.

## 1A Automode front panel

For the control and monitoring of the Automode functions:

- 1 two-position selector for turning the Automode On and Off
- 2 yellow indicator LEDs.

## 2 Panel interface

This main block consists of the board PC 1614 PANEL INTERFACE including its PC1588 MICROPROCESSOR MODULE. The board is connected (via N18, N19 and N40) to the mother board (PC 1617) CONTROL INTERCONNECTION and it has connectors (P81 – P99) for the connection of FRONT PANEL controls.

The FRONT PANEL touch sensors as well as displays and indicator LEDs are integrated parts of this board. Refer to 1 FRONT PANEL in this chapter.

A connector, N20 (on some older PC-boards, the connector is marked N80), is provided on the board for additional function. This connector can be used to connect the optional PC 1745 AUTOMODE PANEL INTERFACE used in SV 300A. This function is described in section 2A AUTOMODE PANEL INTERFACE that can be found after 2.9 MONITOR DISPLAY.

### 2.1 Panel CPU including PAN-PROM functions

This block includes the board PC 1588 with a PAN-PROM. Some details of the PC 1588 are mentioned in section Microprocessor module PC 1588 in this chapter.

The PAN-PROM function includes the handling of input signals from the main block 1 FRONT PANEL, calculation of some displayed values and handling of signals to the displays on the main block 1 FRONT PANEL.

### 2.2 Parameter buffers

Input stage for potentiometers on the main block 1 FRONT PANEL.

### 2.3 Inputs

Analog multiplexor for input signals to the block 2.1 PANEL CPU.

### 2.4 LED matrix

Time multiplexed addressing and driving stages for the block 2.5 LED ARRAY. The input data is given from the block 2.1 PANEL CPU.

### 2.5 LED array

This block contains the light emitting diodes of the front panel bargraphs and the yellow light emitting diodes at the front panel settings.

Some flashing function in front panel bargraphs are mentioned in 4.1 MONITOR/ALARM CPU

### 2.6 Panel display

This block contains all the green alpha-numerical four character light emitting diode displays on the front panel. The input data is given from the block 2.1 PANEL CPU.

### 2.7 Mode select

Input stage for the signals from the front panel Mode selector. The input is available as four bit code and corresponding four bit complementary code generated via the small interconnecting circuit board PC 1632 on the Mode selector. This block gives the data to the block 2.1 PANEL CPU.

## 2.8 Opto switch

Time multiplexed driving stage and sensor receiving stage for all the infra-red sensor touch pads on the front panel. The function is controlled by the block 2.1 PANEL CPU including an automatic adaption of the touch pad sensitivity to the ambient light level. This block gives the data to the block 2.1 PANEL CPU.

## 2.9 Monitor display

This block contains all the red alpha-numerical four character light emitting diode displays as well as eight yellow and eight red alarm indicating light emitting diodes below the Alarms and messages display on the front panel. This block is driven directly from the main block 4 MONITORING.

## 2A Automode panel interface

The board PC 1745 AUTOMODE PANEL INTERFACE contains electronics for handling of the Automode switch.

The status of the switch is given to the blocks 2.1 PANEL CPU, 5 MONITORING and 6 REFERENCE & TIMING. The LEDs are driven from the main block 4 MONITORING.

## Control unit – Control section

The Control section consists of the main blocks 3 – 7 which are described below.

A "mother" board, PC 1617 CONTROL INTERCONNECTION, provides signal connections via connectors (but no electronic functions).

There are five connectors (N80 – N84) on PC 1587.

## 2 3 Computer interface

The ventilator can be equipped with the board PC 1587 COMPUTER INTERFACE to provide the interface functions described below.

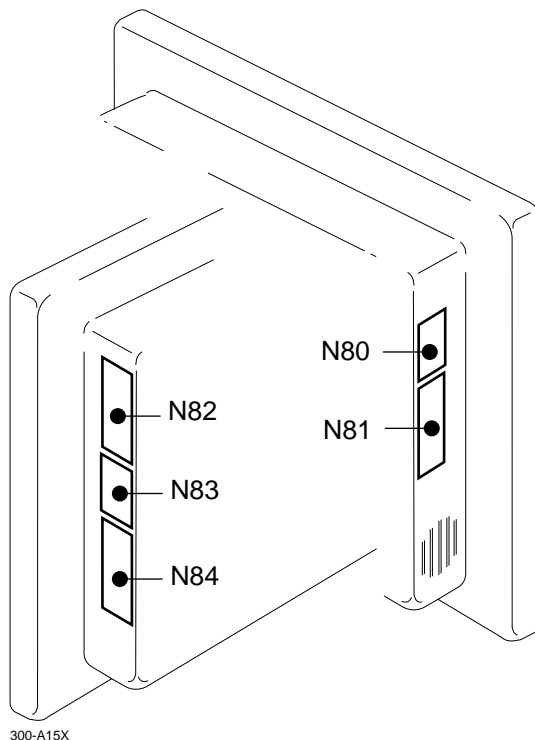
If these interface functions are not needed, the board PC 1665 COMPUTER INTERFACE DUMMY can be mounted instead of PC 1587. The PC 1665-function is described in section 3A COMPUTER INTERFACE DUMMY that can be found after section 3.9 LED INDICATORS.

The board PC 1587 COMPUTER INTERFACE was replaced during the mandatory upgrades:

- **SV 300, Upgrade 1995-09** (US market)
- **SV 300, Upgrade 1995-10** (Rest of World)

As the board PC 1587D was included in these mandatory upgrades, all SV 300/300A must be equipped with PC 1587D (or higher).

The main block COMPUTER INTERFACE consists of the board PC 1587 COMPUTER INTERFACE which includes one microprocessor and a COM-PROM. The COM-PROM is divided in two PROM modules



Only accessories, supplies or auxiliary equipment listed in Siemens-Elema catalogs ("Products and accessories" Order No. 90 34 562 E323E and "Spare and exchange parts" Order No. 90 34 570 E323E) must be connected to or used in conjunction with the ventilator.

**Warning:** Use of accessories and auxiliary equipment other than those specified in these catalogs may degrade safety and performance of the ventilator.



### 3.1 Microprocessor CPU including COM-PROM functions

This includes functions for computer communication (RS-232) via 3.7 SERIAL COMMUNICATION PORTS as described in the Reference Manual "Servo Ventilator 300/300A, Computer Interface (Firmware version 2.X)", Order No. 63 14 061.

This block also contains a real time clock with battery backup, driven by a quartz crystal of 32768 Hz. The purpose of this clock is to time stamp the trend values stored in the ventilator. There is also a possibility to read the actual time through the RS-232 communication.

### 3.2 I/O buffers

Analog and digital input and output stages for the main block 3 COMPUTER INTERFACE.

### 3.3 A/D, D/A

Analog to digital and digital to analog conversion in connection with the block 3.1 MICROPROCESSOR CPU.

### 3.4 Battery

On board mounted Lithium battery (3.5 V). The battery backs up the trend data memory and the real time clock in the block

3.1 MICROPROCESSOR CPU when the SV 300 is switched off.

Normal service interval for exchange of the battery is approx. 5 years. Replacement of the battery is described in chapter "4. Service procedures".

The voltage level in the battery circuit is monitored resulting in an error indication on LED D3 (see 3.9 LED indicators) if the voltage level is below 3.6 V or above 4.5 V. An information message is also displayed on Servo Screen 390 if such unit is connected to the SV 300.

**Note** – The voltage level measured in the battery circuit is higher than the voltage level in the battery itself.

### 3.5 Master/Slave connection

15 pole D-sub connector (N80). Can be used for the synchronization of two Servo Ventilator 300. Only Siemens connection cable must be used.

Pin configuration and signal names can be found in chapter "8. Diagrams".

### 3.6 Analog I/O terminal

62 pole D-sub connector (N81). Can be used for connection of monitoring/recording equipment.

Input control signals can be connected at N81 to control some ventilator functions (e.g. when using Bi-Phasic Ventilation). These input signals are routed via two sockets, J2 and J3, on PC 1587.

To enable the control functions, jumpers must be mounted in the sockets.

Pin configuration, signal names and jumpers can be found in chapter "8. Diagrams".

### 3.7 Serial communication ports

26 pole D-sub connectors (N82 and N83) for RS-232-C data communication. For communication protocol, see Reference Manual "Servo Ventilator 300/300A, Computer Interface (Firmware version 2.X)", Order No. 63 14 061 E380E.

The connectors are identical with one exception; the internal clock can only be set via N82.

Serial communication is indicated on the LEDs D6 – D9. See 3.9 LED INDICATORS.

Pin configuration and signal names can be found in chapter "8. Diagrams".

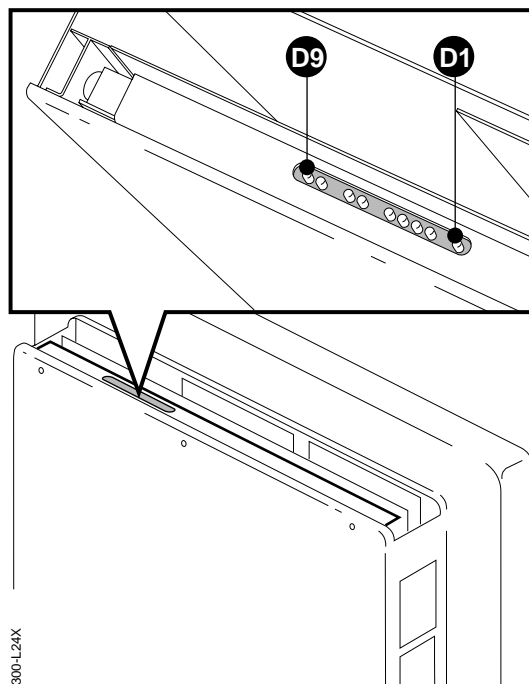
### 3.8 Analog input & Digital code port

44 pole D-sub connector (N84). Optional input interface.

Pin configuration and signal names can be found in chapter "8. Diagrams".

### 3.9 LED indicators

There are 9 green/red LED INDICATORS mounted on PC 1587. The LEDs are visible if the control section cover is removed.



#### LED functions

**D1:** WATCHDOG. During startup the LED will flash for a short moment and then be lit red for a short moment. It will then be lit green again.

When the startup test is completed, the LED indications are as follows:

- Green LED: Microprocessor program is running.
- Red LED: Program error indication.
- LED not lit: Microprocessor program not running.

**D2 – D5:** TEST STATUS LED. Error indications during System startup test. The startup test is divided in several sequences.

The first sequence is a LED test that starts with all LEDs red. The LEDs will then change to green, one at the time (starting with D2), until all four LEDs are green.

In the hardware test sequence, D3 can be of special interest for troubleshooting.

In the first phase of the hardware test, D3 is lit red for a few seconds indicating COM-PROM error. In the second phase of the hardware test, D3 is lit red for a few seconds indicating BATTERY error.

The hardware test sequence ends showing all LEDs green if *no* error was detected and all LEDs red if *any* error was detected.

**Note** – As COM-PROM and BATTERY are the only spare parts for PC 1587, any other LED error indications than mentioned above results in a PC 1587 replacement.

**D6 – D7:** SERIAL INTERFACE 1. Rapidly flashing green and red indicates communication on connector N82. D6 indicates input and D7 indicates output.

**D8 – D9:** SERIAL INTERFACE 1. Rapidly flashing green and red indicates communication on connector N83. D8 indicates input and D9 indicates output.

## 3A Computer interface dummy

The PC 1665 COMPUTER INTERFACE DUMMY is mounted instead of PC 1587 COMPUTER INTERFACE, in the case that there is no need for serial communication with the ventilator.

It is needed as a holder for the PC 1608, as well as for disabling the error signal from the COMPUTER INTERFACE board and the signals for Master – Slave.

## 4 Monitoring

This main block consists of the board PC 1608 MONITORING including its PC 1588 MICROPROCESSOR MODULE and the

4.7 LOUDSPEAKER.

New versions of PC 1608 MONITORING and MON-PROM was introduced in production during 1996 and also as an optional upgrade on delivered units. The upgrade was called "SV 300, ALARM SYSTEM ENHANCEMENT KIT 96-05". The new versions was:

- PC 1608E
- MON-PROM V6.00

As the upgrade was optional and *not* mandatory, a number of *not* upgraded SV 300 are equipped with MON-PROM V5.01 (and PC 1608A, -B, -C or -D). These units must be equipped with a FAILURE ALARM BOX.

**Note** – PC 1608E is backwards compatible and can be equipped with MON-PROM V5.01. The FAILURE ALARM BOX must be used also on these units.

The alarm functions of the FAILURE ALARM BOX are integrated on MON-PROM V6.00/PC 1608E and the FAILURE ALARM BOX is not used on SV 300 equipped with MON-PROM V6.00/PC 1608E (or higher).

For more information about PROM, PC board and Operating Manual versions, see chapter "[6. Product change history](#)".

### 4.1 Monitor/Alarm CPU including MON-PROM functions

This block includes the board PC 1588 with a MON-PROM. Some details of the PC 1588 are mentioned in section Microprocessor module PC 1588 in this chapter. The MON-PROM functions include the (program control) digital monitoring of certain parameters and the activation of alarm functions:

- Front panel indications via the block  
2.9 MONITOR DISPLAY
- Audible indications via the block  
4.3 SOUND & ALARM CONTROL.

In the following description (4.1.1 – 4.1.8) alarms are mentioned in groups, each group associated with corresponding Alarm field within the Front panel field "Alarms and Messages".

For each Alarm field this description of the normal (digital control) alarm contains:

- **Alarms and Messages - Alarm field name**
- Parameter monitored for alarm, PMA and corresponding Reference value
- Alarm table  
containing conditions for alarm.

4.1.1 Airway pressure

PMA:  $P_I$  = INSP. PRESSURE; signal from main block 12 INSPIRATORY PRESSURE.

$P_E$  = EXP. PRESSURE; signal from main block 13 EXPIRATORY PRESSURE.

LIM\_PRESS.L = Signal from the block 6.1 MODE CPU including REF-PROM functions.

Reference value  $P_{max}$  = Preset Upper pressure limit (on Front panel).

Reference value PEEP = Preset PEEP Level (on Front panel).

Alarm table:

"Alarms and messages"	Alarm condition	Remark
Airway pressure too high <sup>2</sup>	$P_I > P_{max}$ <i>or</i> $P_E > P_{max}$	At true condition <sup>1</sup> INSPIRATION is inhibited and EXPIRATION is started.
High continuous pressure	$P_I > PEEP + 15 \text{ cm H}_2\text{O}$ <i>or</i> $P_E > PEEP + 15 \text{ cm H}_2\text{O}$	Alarm if any of the conditions remains true during 15 s.
Limited pressure	LIM_PRESS.L = active, (corresponds to condition: $P_{REF} = P_{max} - 5 \text{ cm H}_2\text{O}$ <i>and</i> resulting Tidal/Minute volume ventilation is less than front panel setting)	LIM_PRESS.L signal <sup>3</sup> only used during PRVC or VS mode. Alarm if the mentioned alarm condition is true during three consecutive breaths.

<sup>1</sup> Refer to 6.1.2 Respiratory timing - condition (3).

<sup>2</sup> Identical condition is also monitored separately within the main block 2. Panel interface and that is used for the following function: At true condition the Airway pressure bargraph indication for Upper pressure limit is flashing.

<sup>3</sup> Refer to 6.1.1 Reference generation - PRVC and VS mode.

Monitoring also controls the following opening and closing of the Safety valve:

Opening condition	Remark
$P_I > P_{max} + 6 \text{ cm H}_2\text{O}$ <i>or</i> $P_E > P_{max} + 6 \text{ cm H}_2\text{O}$	The Safety valve opens. If the opening was caused by any of these conditions the Backup alarm system generates continuous audible alarm.

When opened the Safety valve will stay open until following conditions are true:

Precondition	Closing condition
Safety valve stays open at least during 400 ms.	$P_I < P_{max} + 5 \text{ cm H}_2\text{O}$ <i>and</i> $P_E < P_{max} + 5 \text{ cm H}_2\text{O}$

For Airway pressure alarm also see 4.5 Backup alarm system.

### 4.1.2 O<sub>2</sub> concentration

**PMA:** O<sub>2</sub> concentration = Signal generated within the block 4.1 using O<sub>2</sub> CONC. signal from the block 11.3 O<sub>2</sub> CELL which is digitally compensated for mean airway pressure and barometric pressure according to BAROMETER PRESSURE signal from 4.6 BAROMETER PRESSURE TRANSDUCER.

Reference value Set O<sub>2</sub> = Preset O<sub>2</sub> concentration (on Front panel).

Alarm table:

"Alarms and messages" text	Precondition	Alarm condition
O2 conc too high	21% < Set O <sub>2</sub> < 100%	PMA > Set O <sub>2</sub> + 6%
O2 conc too low	21% < Set O <sub>2</sub> < 24% 24% < Set O <sub>2</sub> < 96% 96% < Set O <sub>2</sub>	PMA < 18% PMA < Set O <sub>2</sub> - 6% PMA < 90%
"Alarms and messages" text	Additional function	
O2 SENSOR	If the O <sub>2</sub> cell is disconnected; High priority alarm that can be changed to a caution signal.	

If above mentioned O<sub>2</sub> concentration alarm condition is true during less than 55 s the alarm is not registered in the alarm memory.

If the O<sub>2</sub> concentration setting is changed more than 2 percentage units, the alarm is automatically muted for maximum 55 s. This also applies at activation of "Oxygen breath".

For O<sub>2</sub> concentration alarm also see 4.5 Backup alarm system.

### 4.1.3 Optional alarm field

On earlier versions of the ventilator, the alarm field name was "CO<sub>2</sub> concentration". This optional alarm field is not used.

4.1.4 Exp. minute volume

PMA: Exp. min. vol. = signal from the block 4.4 FLOW FILTERS & INTEGRATORS.

Reference value  $M_{max}$  = Preset Upper alarm limit for Expired minute volume

Reference value  $M_{min}$  = {The highest of the following two possibilities:}

- = Preset Lower alarm limit for Expired minute volume *or*
- = Lowest value for normal (digital) alarm; value according to table in 1.1. Patient range selection.

Alarm table:

"Alarms and messages" text	Alarm condition
Exp. minute volume too high	$PMA > M_{max}^1$
Exp. minute volume too low	$PMA < M_{min}^2$

<sup>1</sup> Identical condition is also monitored separately within the main block 2 PANEL INTERFACE and that is used for the following function: At true condition the Minute volume bargraph indication for Upper alarm limit is flashing.

<sup>2</sup> Identical condition is also monitored separately within main the block 2 PANEL INTERFACE and that is used for the following function: At true condition the Airway pressure bargraph indication for Lower alarm limit is flashing.

For Exp. minute volume alarm also see 4.5 BACKUP ALARM SYSTEM.

4.1.5 Apnea

PMA: The measured time durations  $T_c$  corresponding to Breath cycle.

$T_c$  = Time duration measured from each Start Inspiration until next Start Inspiration.

Reference value  $T_d$  = {Apnea alarm delay time}, Value according to table in block 1.1 PATIENT RANGE SELECTION.

Alarm table:

"Alarms and messages" text	Alarm condition	Remark
APNEA ALARM	$T_c > T_d$	Activated alarm stays active until reset on Front panel.

If the Mode selector is in position VS *and* Apnea alarm is active the ventilator performs PRVC Mode. See 6.1.2. RESPIRATORY TIMING "condition (A)".

### 4.1.6 Gas supply

**PMA:** Measured gas supply pressures

$P_{AIR}$  = Air supply pressure

$P_{O_2}$  = Oxygen supply pressure

Alarm table:

"Alarms and messages" text	Alarm condition
Air supply pressure too high   Air: X.X bar   O2: X.X bar	$P_{AIR} > 6.5 \text{ bar}$
O2 supply pressure too high   Air: X.X bar   O2: X.X bar	$P_{O_2} > 6.5 \text{ bar}$
Air supply pressure too low   Air: X.X bar   O2: X.X bar	$P_{AIR} < 2.0 \text{ bar}^{1 \text{ \& } 3 \text{ \& } 4}$
O2 supply pressure too low   Air: X.X bar   O2: X.X bar	$P_{O_2} < 2.0 \text{ bar}^{2 \text{ \& } 3 \text{ \& } 4}$

<sup>1</sup> The high priority alarm may be downgraded to a silent caution alarm if the set  $O_2$  concentration is between 98 and 100%.

<sup>2</sup> The high priority alarm may be downgraded to a silent caution alarm if the set  $O_2$  concentration is between 21 and 23%.

<sup>3</sup> In case of  $P_{AIR}$  or  $P_{O_2} < 1.0 \text{ bar}$ , the inspiratory flow is compensated for the missing flow by the remaining gas.

<sup>4</sup> In case of gas failure of both gases, the safety valve and the expiratory valve will open. The alarm in this case:

"Alarms and messages" text	Alarm condition
Air supply pressure too low   O2 supply pressure too low Air: X.X bar   O2: X.X bar	$P_{AIR} < 2.0 \text{ bar}$ <i>and</i> $P_{O_2} < 2.0 \text{ bar}$



4.1.7 Battery

**PMA:** **Measured voltage levels.** External power voltage level: The block 21.3 VOLTAGE CONTROL & TIMING indicates, by the INTERNAL BATTERY MODE signal, in case the external main *and* external battery power voltages are both too low.

$U_{bat}$  = INTERNAL BATTERY VOLTAGE; signal from the block 21.5 BATTERY CHARGE CONTROL.

"Alarms and messages" text	Precondition
BATTERY <i>Note: This message is shown flashing.</i>	INTERNAL BATTERY MODE = active (during > 3.5 s)

Alarm table:

"Alarms and messages" text	Condition
Internal battery voltage too high   Internal: X.X V	$U_{bat} > 33.5 \text{ V}$
Limited battery capacity left   Internal: X.X V	$21 \text{ V} < U_{bat} < 23 \text{ V}$
No battery capacity left   SEE OPERATING MANUAL	$19.5 \text{ V} < U_{bat} < 21 \text{ V}$

Further condition	Remark
$U_{bat} < 19.5 \text{ V}$	No power supply is distributed to the ventilator valves.

4.1.8 Technical

**PMA 1: Start up test results.** Signals generated within the main block 4. MONITORING. The start up test is made once each time the Mode selector is turned from the position Off. The start up test comprises the following parts:

- Power Failure Monitor hardware test. Concerns the function of the hardware which is used as Power Failure Monitor for upper and lower alarm limits for internal Supply Voltages. The function of this Power Failure Monitor hardware is to constitute Alarm limit values for the different supply voltages as shown in Supply voltage, Alarm table in 4.5 BACKUP ALARM SYSTEM. The status of the backup capacitor for this hardware is also checked (the capacitor is also checked regularly during operation).
- Internal RAM test; concerns the RAM within the block 4.1 MONITOR/ALARM CPU
- Internal ROM test; concerns the MON-PROM within the block 4.1 MONITOR/ALARM CPU
- Internal CPU test; concerns the CPU within the block 4.1 MONITOR/ALARM CPU

Alarm Table:

"Alarms and messages" text	PMA 1: Alarm condition Error indication from:
Technical error code PFT RESTART	Power failure test
Technical error code RAM RESTART	Internal RAM test
Technical error code ROM RESTART	Internal ROM test
Technical error code CPU RESTART	Internal CPU test

**PMA 2: Microprocessor failure.** Signals from each of the following blocks:

- 2.1 PANEL CPU (PC 1614 PANEL INTERFACE)
- 3.1 MICROPROCESSOR CPU (PC 1587 COMPUTER INTERFACE)
- 6.1 MODE CPU (PC 1605 REFERENCE & TIMING)
- 7.1 MIXER CPU (PC 1616 INSPIRATORY CONTROL)
- 18.1 LINEARIZING CPU (PC 1615 EXP. FLOW LIN.)

Alarm table:

"Alarms and messages" text	PMA 2: Alarm condition Microprocessor failure signal (repeatedly) from:
Technical error code $\mu$ P Pan SEE OPERATING MANUAL/ RESTART	Panel interface
Technical error code $\mu$ P SCM SEE OPERATING MANUAL/ RESTART	Computer interface
Technical error code $\mu$ P R&T SEE OPERATING MANUAL/ RESTART	Reference & Timing
Technical error code $\mu$ P Mix SEE OPERATING MANUAL/ RESTART	Inspiratory control
Technical error code $\mu$ P Exp SEE OPERATING MANUAL/ RESTART	Exp. flow lin.

**PMA 3: Monitored front panel inputs.** Signals from each of the following blocks:

- 1.1 PATIENT RANGE SELECTION (from Patient range selector)
- 1.3 RESPIRATORY PATTERN (from CMV freq. setting - double potentiometer)
- 1.5 O<sub>2</sub> CONCENTRATION (from O<sub>2</sub> concentration setting - double potentiometer)
- 1.8 MODE SELECTION (from Mode selector via 2.8 Mode select - Input stage)

2

Alarm table:

"Alarms and messages" text	PMA 3: Alarm condition Certain difference exceeded (repeatedly) between the two Front panel inputs coming in pair from:
Technical error code SwR SEE OPERATING MANUAL	Patient range switch
Technical error code SwM SEE OPERATING MANUAL	Mode selector
Technical error code PoC SEE OPERATING MANUAL	CMV frequency setting
Technical error code PoO SEE OPERATING MANUAL	O <sub>2</sub> concentration setting

**PMA 4: P<sub>B</sub>.** Barometer pressure (signal from 4.6 BAROMETER PRESSURE TRANSDUCER)

Alarm table:

"Alarms and messages" text	PMA 4: Alarm condition
Technical error code Ba SEE OPERATING MANUAL	P <sub>B</sub> < 700 mbar <i>or</i> P <sub>B</sub> > 1100 mbar

**PMA 5: Internal supply voltages.** Failure signal from Power Failure Monitor hardware (part of the block 4.5 BACKUP ALARM SYSTEM).

Reference values (alarm limits) according to 4.5 BACKUP ALARM SYSTEM.

Alarm table:

"Alarms and messages" text	PMA 5: Alarm condition
Technical error code PF SEE OPERATING MANUAL	Alarm if the signal POWER_FAILURE.H is constantly activated during more than 1 s.

2

**PMA 6:**  $P_I$  = Insp. pressure, signal from main block 12 INSPIRATORY PRESSURE, and  $P_E$  = Exp. pressure, signal from main block 13 EXPIRATORY PRESSURE, are used to generate:

$P_1$  = the mean value of  $P_I$  during inspiration time

$P_2$  = the mean value of  $P_E$  during inspiration time

$P_3$  = the mean value of  $P_I$  during the first 80 ms of expiration time

$P_4$  = the mean value of  $P_E$  during the first 80 ms of expiration time

$P_5$  = the mean value of  $P_E$  during the last 32 ms of expiration time

$P_6$  = the mean value of  $P_E$  during the time period 40 - 80 ms from start exp. time

Reference value PEEP = Preset PEEP Level (on Front panel).

Alarm table:

"Alarms and messages" text	PMA 6: Alarm condition	Remark
CHECK TUBINGS	$P_1 > 15 \text{ cm H}_2\text{O and}$ $P_2 < 4 \text{ cm H}_2\text{O and}$ $P_4 < 4 \text{ cm H}_2\text{O and}$ $P_5 - P_6 < 1 \text{ cm H}_2\text{O and}$ $P_3 > \text{PEEP} + 12 \text{ cm H}_2\text{O}$	Alarm if all 5 conditions are true. Each time when this alarm starts, the safety valve opens for 5 s.

**PMA 7: OverrangeErr** signal from 7.1 MIXER CPU, indicating high Ref. value for flow, and the following Tidal Volume signals:

$TV_I$  = Tidal Volume output value from Insp. Flow Integrator (block 4.4 )

$TV_E$  = Tidal Volume output value from Exp. Flow Integrator (block 4.4 )

$TV_{SET}$  = Tidal Volume value according to Front panel setting (corresp. to green display).

Alarm table:

"Alarms and messages" text	PMA 7: Alarm condition Patient range selected: <b>Neonate</b>	Remark
OVERRANGE: Select PEDIATRIC	Overrange signal active from 7.1 MIXER CPU indicating high Ref. value for Flow (F). @ $F > 0.22 \text{ l/s}^1$ $TV_I > 39.5 \text{ ml}^{1 \& 2}$ $TV_E > 39.5 \text{ ml}^{1 \& 3}$ $TV_{SET} > 34.0 \text{ ml}^4$	Alarm if any of these conditions is true. <sup>4</sup>

"Alarms and messages" text	PMA 7: Alarm condition Patient range selected: <b>Pediatric</b>	Remark
OVERRANGE: Select ADULT	Overrange signal active from 7.1 MIXER CPU indicating high Ref. value for Flow (F). @ $F > 0.55 \text{ l/s}^1$ $TV_I > 395 \text{ ml}^{1 \& 2}$ $TV_E > 395 \text{ ml}^{1 \& 3}$ $TV_{SET} > 340 \text{ ml}^4$	Alarm if any of these conditions is true. <sup>4</sup>

"Alarms and messages" text	PMA 7: Alarm condition Patient range selected: <b>Adult</b>	Remark
–	Overrange signal active from 7.1 MIXER CPU indicating high Ref. value for Flow (F). @ $F > 3.3 \text{ l/s}$	This overrange signal is not used for alarm.

<sup>1</sup> The acoustical part of the alarm is delayed 10 s.

<sup>2</sup> The Front panel red display Insp. tidal volume is flashing.

<sup>3</sup> The Front panel red displays Exp. tidal volume and Exp. minute volume are flashing.

<sup>4</sup> The condition concerning  $TV_{SET}$  is considered only during PRVC Mode

## 4.2 Inputs interface & A/D

Multiplexor and analog to digital conversion stages for input signals to the main block 4 MONITORING.

## 4.3 Sound & Alarm control

Alarm control circuits including the driving stage for the block 4.7 LOUDSPEAKER.

## 4.4 Flow filters & Integrators

The input signals AIR FLOW and O<sub>2</sub> FLOW are added to generate INSP. FLOW (block internal signal INSP. FLOW SUM).

The difference between the signals INSP. FLOW SUM and EXP. FLOW generates the signal AIRWAY FLOW (= block internal signal EXP. FLOW INT.) as well as the signals INSP. FLOW PATIENT and EXP. FLOW PATIENT. This way of calculating is necessary to achieve the last two mentioned signals of patient flow during EXPIRATION TIME when a constant flow to the patient system is generated via the inspiratory valve(valves).

Integration during each breath of the signal INSP. FLOW SUM generates INSP. TIDAL VOL. The signal INSP. FLOW PATIENT is averaged to generate INSP. MIN. VOL.

Integration during each breath of the signal EXP. FLOW INT. generates EXP. TIDAL VOL. The signal EXP. FLOW PATIENT is averaged to generate EXP. MIN. VOL.

Some of the signals are used for monitor/ alarm within this main block, some of them used for mode regulation algorithms by the block 6.1 MODE CPU and some of them displayed on the front panel. The signals INSP. FLOW PATIENT and EXP. FLOW PATIENT are available at the 3.6 ANALOG I/O TERMINAL.

## 4.5 Backup alarm system

The internal power supply voltages are monitored in this block. If any of the voltage limits are exceeded, the supply voltage alarm is activated by the signal POWER\_FAILURE.H.

The parameters AIRWAY PRESSURE (upper alarm limit) and O<sub>2</sub> CONC and EXP. MINUTE VOLUME are monitored (analog monitoring) at somewhat wider alarm limits than the corresponding digital monitoring function of the block 4.1 MONITOR/ALARM CPU. This block activates an alarm only if the regular (digital) alarm system is failing.

This block includes the driving stage for the block 4.8 BEEPER.

Active backup alarm consists of intermittent (in some case continuous) audible alarm generated by means of the 4.8 BEEPER.

Preconditions for backup alarm: Alarm condition mentioned below is fulfilled *and* normal (digital control) alarm is not active. In this connection the normal alarm is considered not active also in case of loudspeaker error (indicated via the Loudspeaker supervisor function connected to the Sound generation function in the block 4.3 SOUND & ALARM CONTROL).

Special condition leading to active Backup alarm is mentioned under 4.1 MONITOR/ALARM CPU.

The Backup alarm system contains the following different **PMA = Parameter Monitored for Alarm**. Each alarm table contains conditions for alarm.

### 4.5.1 Supply voltage

PMA = Internal supply voltages.

Reference values as shown in the following Alarm table.

Alarm table:

Supply voltage	Alarm limit	Alarm condition	Remark
+5 V +15 V -15 V +24 V	±5% ±10% ±10% > 33 V, < 18.5 V	If any alarm limit is exceeded, the signal POWER_FAILURE.H IS activated.	If the signal POWER_FAILURE.H IS constantly activated during more than 1 s, the ventilator stops operating <sup>1</sup> and alarm is activated <sup>2</sup> .

<sup>1</sup> The signal POWER\_FAILURE.H will activate functions to open the SAFETY VALVE and EXPIRATORY VALVE and close the INSPIRATORY VALVES.

<sup>2</sup> If the +5 V alarm limit is exceeded; only the Backup alarm system, generating an intermittent audible alarm, is activated. "Alarms and messages text" and/or flashing LEDs will *not* be given on the front panel. All front panel LEDs, indications and displays, will be turned off.

If any of the +15 V, -15 V or +24 V alarm limits are exceeded; the normal (digital control) alarm (see 4.1.8 Technical, PMA 5) *and* the Backup alarm system, generating an intermittent audible alarm, are activated. "Alarms and messages text" and/or flashing LEDs will be given on the front panel.

Restart the ventilator.

### 4.5.2 Airway pressure

PMA: P<sub>I</sub> = Insp. pressure; signal from main block 12 INSPIRATORY PRESSURE),

P<sub>E</sub> = Exp. pressure; signal from main block 13 EXPIRATORY PRESSURE).

Reference value P<sub>max</sub> = Preset Upper pressure limit (on Front panel).

Alarm table:

Alarm condition	Remark
P <sub>I</sub> > P <sub>max</sub> +6 cm H <sub>2</sub> O <i>or</i> P <sub>E</sub> > P <sub>max</sub> +6 cm H <sub>2</sub> O	As long as the Safety valve stays open caused by any of these conditions, the Backup alarm system generates continuous audible alarm.



4.5.3 O<sub>2</sub> concentration

PMA = O<sub>2</sub> concentration; signal generated within the block 4.5 using o2\_CONC. signal from the block 11.3 O<sub>2</sub> CELL which is analogically compensated for barometric pressure according to BAROMETER PRESSURE signal from 4.6 BAROMETER PRESSURE TRANSDUCER.

Reference value Set O<sub>2</sub> = Preset O<sub>2</sub> concentration (on Front panel).

Alarm table:

Precondition	Alarm condition
21% < Set O <sub>2</sub> < 26%	PMA < 16%
26% < Set O <sub>2</sub> < 100%	PMA < (Set O <sub>2</sub> – 10%)
21% < Set O <sub>2</sub> < 100%	PMA > (Set O <sub>2</sub> + 10%)

2

4.5.4 Exp. minute volume

PMA = Exp. minute volume; Signal from block 4.4 FLOW FILTERS & INTEGRATORS.

M<sub>max</sub> = 1.1 x Preset Upper alarm limit for Expired minute volume

M<sub>min</sub> = {The highest of the following two possibilities:}  
= 0.9 x Preset Lower alarm limit for Expired minute volume *or*  
= Lowest value used for backup alarm, see 1.1 PATIENT RANGE SELECTION.

Alarm table:

Alarm condition
PMA > M <sub>max</sub> PMA < M <sub>min</sub>

## 4.6 Barometer pressure transducer

Pressure sensor measuring the ambient pressure. The signal is used in the block 8.11 PRESSURE CALCULATOR for the regulation of inspiratory flow in the main block 8 INSPIRATORY VALVE UNIT – AIR as well as in the main block 9 INSPIRATORY VALVE UNIT – O<sub>2</sub>.

The measured value can be read in the Alarm and messages display on the front panel, see chapter Calibration in the SV 300 – Operating Manual.

## 4.7 Loudspeaker

For audible alarm generated by the regular (digital) monitor/alarm block 4.1 MONITOR/ALARM CPU.

## 4.8 Beeper

Tone generator for audible alarm controlled by the (analog) block 4.5 BACKUP ALARM SYSTEM.

## 4.9 Failure alarm box (FAB)

A FAILURE ALARM BOX (FAB) must be installed on SV 300 equipped with MON-PROM V5.01. The alarm functions of the FAB are integrated on MON-PROM V6.00/PC 1608E and the FAB is *not* used on SV 300 equipped with MON-PROM V6.00/PC 1608E (or higher). See section "4 MONITORING" for further information regarding PROM and PC board versions.

The FAB is mounted on the SV 300 connector N81. All functionality of the SV 300 Analog I/O terminal N81 is available through the one-to-one connected FAB connector N81.

The FAB includes the functional blocks:

+24 V MONITOR

FAB INTERNAL MONITOR

ALARM CONTROL

A FAB BEEPER, a red LED, a push button and the connector N81 (as described above) are also included in the FAB.

The FAB is designed to detect loss of the SV 300 internal +24 V power and emits audible alarm in response to such a power failure or in case of a FAB internal failure.

For a further functional description of the FAB, contact your Siemens representative.

## 5 Optional PC board slot

Not used in this version.

## 6 Reference & Timing

This main block consists of the board PC 1605 REFERENCE & TIMING including its PC 1588 MICROPROCESSOR MODULE.

### 6.1 Mode CPU including REF-PROM functions

This block includes the board PC 1588 with a REF-PROM. Some details of the Microprocessor module PC 1588 are mentioned in section General in this chapter. The REF-PROM functions contain the different algorithms for the breathing pattern in different Modes.

The description of this block function is divided below into two principle block parts:

- 6.1.1 Reference generation
- 6.1.2 Respiratory timing.

#### 6.1.1 Reference generation

A reference signal is generated for inspiratory control. During Inspiration time the signal is in principle a constant level according to front panel settings. This level is reached via a linear slope which covers a certain rise time according to Insp rise time %, Front panel setting. During Expiration time the signal is another constant level.

The signal is handled in one of two different ways depending on if flow regulation or pressure regulation is used. The same signal is therefore referred to with two different signal names in the block diagram. The signal names are:

- FLOW REGULATION FLOW REF for flow regulation.
- PRESSURE REGULATION PRESSURE REF for pressure regulation.

### Flow regulation

For flow regulation the signal FLOW REGULATION FLOW REF is directly used by the block 7.3 MIXER in the main block 7 INSPIRATORY CONTROL as reference for the total flow.

Flow regulation is used during expiration time in all modes. The constant flow during expiration time depends on the selected patient range. Ref. block 1.1 Patient range selection.

Flow regulation is used during inspiration time in Volume Control mode and during inspiration time for the mandatory breaths in SIMV (Vol. Contr.) mode as long as "on demand flow" is not activated. As long as flow regulation is active FLOW REGULATION FLOW REF =

$$\frac{\text{Minute vol. (front panel setting)}}{\text{Insp. time \% (front panel setting)}}$$

**Note** – For the case when Insp rise time is in use above formula actually gives the *mean value* of FLOW REGULATION FLOW REF during the time this flow regulation is active. This implies that the constant (end insp.) value of FLOW REGULATION FLOW REF is somewhat higher.

## Pressure regulation

For pressure regulation the signal  $P_{\text{REGULATION PRESSURE REF}}$  is used by the block 6.4  $P_{\text{PRESSURE PID CONTROL}}$ .

Pressure regulation is used during inspiration time when Flow regulation (as described above) is not used. In this case the  $P_{\text{REGULATION PRESSURE REF}}$ ,  $P_{\text{REF}}$  used by the block 6.4  $P_{\text{PRESSURE PID CONTROL}}$  during inspiration time is generated as follows depending on the mode in use.

**Note** – During Pressure regulation the above mentioned slope at the beginning of Inspiration time (when using Insp. rise time) always starts at a pressure level = PEEP.

### Pressure Control mode

The  $P_{\text{REGULATION PRESSURE REF}}$  signal will adopt the value

$$P_{\text{REF}} = \text{PEEP} + \text{Pressure Control Level above PEEP}$$

using values according to corresponding settings from the main block 1  $P_{\text{FRONT PANEL}}$ .

### Volume Control mode

If "on-demand-flow" is activated the  $P_{\text{REGULATION PRESSURE REF}}$  signal will adopt the value

$$P_{\text{REF}} = \text{PEEP}$$

using PEEP value according to Front panel setting.

### Pressure Reg. Volume Control (PRVC) mode and Volume Support (VS) mode

The value of  $P_{\text{REGULATION PRESSURE REF}}$ ,  $P_{\text{REF}}$  is handled as the sum of two parts according to the following addition:

$$P_{\text{REF}} = \text{PEEP} + P_{\text{IN USE}}$$

PEEP is the Positive End Expiratory Pressure level according to Front panel setting and  $P_{\text{IN USE}}$  is an additional Pressure level above PEEP.

$P_{\text{IN USE}}$  is assigned a new calculated value each breath.

$P_{\text{IN USE}}$  keeps a constant value during each inspiration time (except during Insp. rise time).

$P_{\text{IN USE}}$  is generally limited to fulfill the following two conditions:

$$P_{\text{IN USE}} > 0.1 \text{ cm H}_2\text{O} \\ (= \text{minimum value for } P_{\text{IN USE}})$$

$$P_{\text{REF}} < P_{\text{max}} - 5 \text{ cm H}_2\text{O} \\ (\text{implies a maximum value for } P_{\text{IN USE}})$$

where  $P_{\text{max}}$  = Upper pressure limit (Front panel setting).

The value of the parameter  $P_{\text{IN USE}}$  used during breath number  $n$  (during inspiration number  $n$ ) is

$$P_{\text{IN USE}(n)} = P_{\text{REF}(n)} - \text{PEEP}$$

where  $P_{\text{REF}(n)}$  is the value of the parameter  $P_{\text{REF}}$  calculated to be used during breath number  $n$  (during inspiration number  $n$ ).

A calculation is made at the end of inspiration  $n$  to achieve a new calculated pressure value  $P_{\text{CALC}(n)}$  using one of the formulas (1) or (2) or (3) below.

$$P_{\text{CALC}(n)} = P_{\text{in use}(n)} \times \frac{TV_P}{TV_M} \quad (1)$$

$$P_{\text{CALC}(n)} = P_{\text{in use}(n)} \times \frac{MV_P}{MV_M} \quad (2)$$

$$P_{\text{CALC}(n)} = P_{\text{in use}(n)} \times \frac{TV_P}{TV_M} \times 150\% \quad (3)$$

$TV_P$  = Preset Tidal Volume

$TV_M$  = Measured Inspiratory Tidal Volume

$MV_P$  = Preset Minute Volume

$MV_M$  = Measured Inspiratory Minute Volume

The following choice is made between formulas (1), (2) and (3):

**(1)** if the calculated breathing frequency  $f_{\text{CALC}}$  fulfills:

$$f_{\text{CMV}} = f_{\text{CALC}} \quad \text{or}$$

$$f_{\text{CMV}} < f_{\text{CALC}}$$

Applicable both for the PRVC mode and for the VS mode.

**(2)** if the calculated breathing frequency  $f_{\text{CALC}}$  fulfills:

$$2/3 \times f_{\text{CMV}} < f_{\text{CALC}} < f_{\text{CMV}}$$

Only applicable for the VS mode.

**(3)** if the calculated breathing frequency  $f_{\text{CALC}}$  fulfills:

$$f_{\text{CALC}} < 2/3 \times f_{\text{CMV}}$$

Only applicable for the VS mode.

The value  $f_{\text{CMV}}$  is the CMV frequency according to front panel setting.

The parameter  $f_{\text{CALC}}$  is calculated every breath (in VS mode). In breath number  $n$  the value is

$$f_{\text{CALC}(n)} = \frac{1}{T_{(n)}}$$

$T_{(n)}$  is the measured time from end of inspiration number  $n-1$  to end of inspiration number  $n$ .

The result of the above choice of formula, **(1)** or **(2)** or **(3)** is that the target Tidal Volume (TV) depends on the calculated Breathing frequency ( $f_{\text{CMV}}$ ) as illustrated in the diagram:

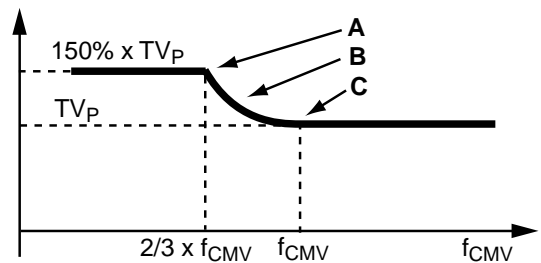


Diagram: Target Tidal Volume vs calculated Breathing frequency

**A:** Const. Tidal Volume  $TV = 150\% \times TV_P$  **(3)**

**B:** Const. Minute volume  $MV = MV_P$  **(2)**

**C:** Const. Tidal Volume  $TV = TV_P$  **(1)**

The calculated pressure value  $P_{\text{CALC}(n)}$  is used to calculate the pressure difference value:

$$P_{\text{DIFF}(n)} = P_{\text{CALC}(n)} - P_{\text{IN USE}(n)} \quad (4)$$

The parameter  $P_{\text{DIFF}}$  is thus updated once every breath.  $P_{\text{DIFF}}$  is used to assign a new value to the parameter  $P_{\text{REF}}$  to be used during the next breath (during inspiration number  $n+1$ ):

$$P_{\text{REF}(n+1)} = P_{\text{REF}(n)} + F_{(n)}(P_{\text{DIFF}}) \quad (5)$$

The value of  $F$  depends on the value of  $P_{\text{DIFF}}$ .

F is one of two possible functions **(6)** or **(7)** stated below although the value of F used when performing the calculation according to the formula **(5)** in each case is limited to make sure that the calculated value of  $P_{REF}$  will never exceed  $P_{REFmax} = P_{max} - 5 \text{ cm H}_2\text{O}$ .

If  $P_{REF(n)} = P_{max} - 5 \text{ cm H}_2\text{O}$  and  $P_{DIFF(n)} > 0$

for three consecutive breaths a failure signal (LIM\_PRESS.L) is transmitted to the block

4.1 MONITOR/ ALARM CPU to activate the Airway pressure alarm - "Limited pressure".

Normal procedure:

Definition of function **(6)**:

Assume the parameter  $P_{DIFF}$  being continuously filtered via low pass filter with the time constant:

$\tau = 9 \text{ sec}$  for the mode PRVC

$\tau = 18 \text{ sec}$  for the mode VS

The filtered value  $F = P_{DIFF} \times (1 - e^{-T/\tau})$

T is the measured duration time of the foregoing breath cycle.)

The value of the parameter F during Normal procedure is the low pass filtered value of  $P_{DIFF}$  sampled at the end of the inspiration (number n):

$$F_{(n)} = P_{DIFF(n)} \times (1 - e^{-T(n)/\tau})$$

$T_{(n)}$  is the measured time from end of inspiration number  $n - 1$  to end of inspiration n.

During Normal procedure the value of the parameter F is limited to:

$-3 \text{ cm H}_2\text{O} < F_{(n)} < 3 \text{ cm H}_2\text{O} = \text{max amount}$

End of function **(6)**

The change of pressure reference level from one breath to the next breath during Normal procedure is a calculated, low pass filtered difference value.

Limitation 1: The change (increase or decrease) of  $P_{REF}$  from one breath to the next breath is limited to max 3 cm H<sub>2</sub>O.

Limitation 2: If during one inspiration any of the conditions (10) or (11) is valid as described in block part 6.1.2 the inspiration will be stopped and the pressure reference level for the next breath ( $n + 1$ ) will be reduced:

$$P_{REF(n+1)} = P_{REF(n)} - \text{Reduction}$$

$$\text{Reduction} = 0.75 \times P_{INUSE}$$

Max value of this Reduction = 20 cm H<sub>2</sub>O

Start up procedure:

The start up procedure consists of one test breath (number:  $n = 1$ ) and the following 3 breaths (numbers:  $n = 2, 3$  and 4).

$$P_{INUSE(1)} = 5 \text{ cm H}_2\text{O}$$

Definition of function **(7)**:

In order to achieve the values of the parameter  $P_{REF}$  [ref. formula **(5)**] to be used during the breaths number 2 and 3 and 4 within the Start up procedure the values  $F_{(n)}$  for  $n = 1$  and  $n = 2$  and  $n = 3$  are needed: Each value of the parameter F during Start up procedure uses the formula

$$F_{(n)} = P_{DIFF(n)} \times 0.75$$

Note: No use of low pass filter.

During Start up procedure the value of the parameter F is limited to

$$F_{(n)} < 20 \text{ cm H}_2\text{O} (= \text{maximum value})$$

End of function **(7)**

The change of pressure reference level from one breath to the next breath within these 4 breaths is 75% of the change of pressure as calculated by the above mentioned formula **(4)**. Limitation: The increase of  $P_{REF}$  from one breath to the next breath is limited to max 20 cm H<sub>2</sub>O.

For  $n > 3$ : The value of the parameter  $P_{REF}$  [ref. formula **(5)**] to be used during breath number 5, and following breaths, will follow the Normal procedure as described above.

The start up procedure is initiated at any one of the following conditions (S) or (T):

(S): The Mode selector is changed to this mode (PRVC or VS).

(T): If at least 15 sec have passed since last Start up procedure started and if at least 5 breaths have passed since last Start up procedure started and if then a single breath ends with  $TV_M < 50\% \times TV_P$ . This condition will normally occur at reconnection of a patient after disconnection.

### *SIMV (Vol. Contr.) + Pressure Support mode*

For the mandatory breaths; see Volume Control mode above. For the spontaneous breaths; see Pressure Support mode below.

### *SIMV (Press. Contr.) + Pressure Support mode*

For the mandatory breaths; see Pressure Control mode above. For the spontaneous breaths; see Pressure Support/CPAP mode below.

### *Pressure Support/CPAP mode*

Pressure Support mode:

This mode is active if the front panel setting Pressure Support Level above PEEP:  $> 2$  cm H<sub>2</sub>O

In this case the PRESSURE REGULATION PRESSURE REF signal will adopt the value:

$$P_{REF} = \text{PEEP} + \text{Pressure Support Level above PEEP}$$

using values according to corresponding settings from the main block 1 FRONT PANEL.

CPAP mode:

This mode is active if the front panel setting Pressure Support Level above PEEP  $- 2$  cm H<sub>2</sub>O.

In this case the PRESSURE REGULATION PRESSURE REF signal will adopt the value:

$$P_{REF} = \text{PEEP level} + 2 \text{ cm H}_2\text{O}$$

### 6.1.2. Respiratory timing

Timing is defined by the internal respiratory phase control signals for INSP TIME and PAUSE TIME and EXP TIME which are generated in this block. When the Mode selector is in any other position than Ventilator off or Stand by one of these three control signals is always active (HI), only one at a time. PAUSE TIME is in use only if any of the Front panel functions Pause time % or Pause hold is active. Three LEDs at the top end of the PC 1605 marked INSP, PAUSE and EXP are used to indicate the current respiratory phase.

During controlled ventilation, as well as for mandatory breaths, the respiratory phase control signals are related to the front panel settings Insp. time % and Pause time % and to the internal respiratory CLOCK signal which has a frequency defined by the front panel setting CMV frequency.

During SIMV modes the Front panel setting SIMV frequency is in use. The SIMV frequency defines the duration of the SIMV cycle. The first part of each SIMV cycle is a waiting period referred to as the SIMV period. The duration of the SIMV period is defined by the front panel setting CMV frequency.

The INSP TIME signal is also used in the main block 18 EXPIRATORY FLOW LINEARIZATION for zeroing of the EXPIRATORY FLOW TRANSDUCER signal in the block 18.3 ZERO OFFSET.

Additionally, timing control of the offset zeroing for the inspiratory flow regulation within each INSPIRATORY VALVE UNIT is generated and transferred via the blocks 15.4 VALVE ZEROING and 15.5 VALVE ENABLING. Thus the inspiratory valves are enabled during inspiration time and (for the constant flow) during expiration time with the following exception. This offset zeroing takes place during each pause time if pause time is available. When pause time is not applied the enabling of the inspiratory valves excludes the first 40 ms of each expiration

time and that period is used for this offset zeroing.

Additionally, timing control of the offset zeroing for the position signal within the block 16.3 EXPIRATORY SOLENOID WITH POSITION SENSOR is generated and transferred via the block 15.4 VALVE ZEROING during INSPIRATION TIME. The main block 16 EXPIRATORY VALVE (regulation of opening) is enabled during expiration time.

### Timing conditions

Definition of parameters:

$$P_E = \text{EXP. PRESSURE}$$

$$P_I = \text{INSP. PRESSURE}$$

The internal respiratory CLOCK signal is a pulse train with the Clock frequency =  
= 100 x Preset CMV frequency

$$\text{Clock cycle} = (\text{Clock frequency})^{-1}$$

$$\begin{aligned} \text{Duration of SIMV PERIOD} &= \\ &= 90 \times \text{Clock cycle} \end{aligned}$$

$$\begin{aligned} \text{Breath cycle} &= (\text{Preset CMV frequency})^{-1} = \\ &= 100 \times \text{Clock cycle} \end{aligned}$$

$$\text{SIMV cycle} = (\text{Preset SIMV frequency})^{-1}$$

Numeric calculation note:

$$\text{Cycle in seconds} = 60 \times \text{Cycle in minutes}$$



Timing conditions for Start and for Stop of  
INSPIRATION valid during different modes  
of ventilation:

Mode	Start condition	Stop condition <u>Underlined</u> condition is normally more probable
Pressure control	(P) or (V)	( <u>0</u> ) or (3) or (4)
Volume control	(P) or (V)	If Flow regulation has been in use during the entire Inspiration time: ( <u>0</u> ) or (3) or (9) Else if Flow regulation is in use: (3) or (5) or ( <u>8</u> )
On demand flow	(D)	----- Pressure regulation: (1) or (3) or (5) or (6) or ( <u>7</u> )
Pressure Regulated Volume Control	(P) or (V)	( <u>0</u> ) or (3) Additional limiting condition as long as the [measured INSP. PRESSURE > (Preset PEEP + 5 cm H <sub>2</sub> O)]: (10)
Start up	(S) or (T)	----- The Start up procedure is finished after four breaths
Volume Support	(P)	( <u>1</u> ) or (2) or (3) or (5) or (6) Additional limiting condition as long as the measured INSP. PRESSURE > (Preset PEEP + 5 cm H <sub>2</sub> O): (11)
Start up	(S) or (T)	----- The Start up procedure is finished after four breaths
SIMV (Vol. Control)	(P) or (M)	Mandatory breaths: See Volume Control (above)
+ Pressure Support	(P)	----- "Spontaneous" breaths: See Pressure Support (below)
SIMV (Press. Control)	(P) or (M)	Mandatory breaths: See Pressure Control (above)
+ Pressure Support	(P)	----- "Spontaneous" breaths: See Pressure Support (below)
Pressure Support/CPAP	(P)	( <u>1</u> ) or (2) or (3) or (4) or (5) or (6)
In any mode	(B)	According to applicable mode above

Explanation of Start and Stop conditions;  
*Front panel setting on which it depends:*

Start conditions

- (B) Front panel initiation of a breath during EXP. time;  
*Start breath*
- (D) Patient initiation of On demand flow during INSP. time:  
 $P_E < (PEEP - 2 \text{ cm H}_2\text{O})$ ;  
*Preset PEEP*
- (M) Ventilator start of a mandatory breath during SIMV Modes: The first part of each SIMV cycle is a waiting period - the SIMV period. If no (P) occurs during a SIMV period, (M) occurs at the end of the SIMV period;  
*Preset SIMV frequency and preset CMV frequency*
- (P) Patient trigger during EXP. time (see 6.2);  
*Preset Trigger sensitivity Level below PEEP*
- (S) Mode change from any other mode to this mode;  
*Mode selector*
- (T) During normal procedure (as described in 6.1.1) if at the end of inspiration the measured Insp. tidal volume  $< 50\% \times$  preset Insp. tidal volume (Further details in 6.1.1, PRVC and VS mode.);  
*Preset Insp. tidal vol.*
- (V) Ventilator start of a breath; (V) occurs each time the internal respiratory CLOCK signal has emitted 100 clock pulses since last start of inspiration time;  
*Preset CMV frequency.*

Stop conditions

- (0) Ventilator stop insp.;  
 Time duration since last start insp. =  
 $= (\text{Preset insp. time } \%) \times 1/100 \times \text{Breath cycle}$   
*Preset Insp. time % and preset CMV frequency*
- (1)  $\text{INSP. FLOW} < 5\% \times \text{Peak INSP. FLOW}$  during same inspiration
- (2)  $\text{INSP. FLOW} < 25\% \times \text{Peak INSP. FLOW}$  during same inspiration and  
 $P_E > (\text{PEEP} + \text{Pressure support level above PEEP} + 8 \text{ cm H}_2\text{O})$ ;  
*Preset PEEP and preset Pressure Support Level above PEEP*
- (3)  $P_E$  or  $P_I > \text{Upper pressure limit}$ ;  
*Preset Upper pressure limit*
- (4)  $P_I > (\text{PEEP} + \text{Pressure ... level above PEEP} + 20 \text{ cm H}_2\text{O})$ ;  
*Preset PEEP and preset Pressure (Control or Support) Level above PEEP.*
- (5) Duration of INSP. TIME  $> 80\% \times \text{Breath cycle}$ ;  
*Preset CMV frequency*
- (6) (Duration of the time when  $\text{INSP. FLOW} < 25\% \times \text{Peak INSP. FLOW}$  during same inspiration)  $>$  (Duration of the time when  $\text{INSP. FLOW} > 25\% \times \text{Peak INSP. FLOW}$  during same inspiration)
- (7)  $\text{INSP. FLOW} < \text{Preset Insp. flow}$ ;  
*Preset Insp. flow*
- (8) Measured Insp. tidal volume  $> 100\% \times \text{Preset Insp. tidal volume}$ ;  
*Preset Insp. tidal vol.*

(9) Measured Insp. tidal volume >  
 $125\% \times \text{Preset Insp. tidal volume};$   
*Preset Insp. tidal vol.*

(10) Measured Insp. tidal volume >  
 $150\% \times \text{Preset Insp. tidal volume};$   
*Preset Insp. tidal vol.*

(11) Measured Insp. tidal volume >  
 $175\% \times \text{Preset Insp. tidal volume};$   
*Preset Insp. tidal vol.*

Timing conditions valid during Pause time.  
 Pause time is available only in Volume  
 Control Mode and mandatory breaths in  
 SIMV (Volume Control):

(3) See above

(12) Duration of Pause time >  
 Preset Pause time;  
*Preset Pause time % and preset CMV  
 frequency*

(13) (Duration of Inspiration time + Pause  
 time) >  $(80\% \times \text{BREATH CYCLE});$   
*Preset CMV frequency*

Additional condition used during Volume  
 Support mode:

(A) If the block 4.1 MONITOR/ALARM CPU  
 indicates active Apnea alarm;  
*Preset Patient range*

When above mentioned condition is true it  
 will lead to the following timing:

(A) Use of the mode Pressure Reg. Volume  
 Control (with Front panel Mode  
 indication flashing).

(B) Start of inspiration time. The (B) reaction  
 is inhibited by the block 6.1 MODE CPU  
 during inspiration time and during the  
 first 40 ms after end of inspiration time.  
 In SIMV Modes the started breath will  
 be a mandatory breath (independent of  
 SIMV cycle phase).

(D) During inspiration time, when Flow  
 regulation is in use: Change to "On  
 demand flow" which means Pressure  
 regulation with (PRESSURE REG. PRESSURE  
 REF. level) = (Preset PEEP level).  
 The (D) reaction is inhibited by the block  
 6.1 MODE CPU during 40 ms from the  
 moment of time when (7) is used to  
 change back to flow regulation.

(M) Start of Inspiration time. This will be a  
 mandatory breath.

(P) Start of Inspiration time. The (P) reaction  
 is always inhibited by the block 6.1 MODE  
 CPU during Inspiration time and during  
 the first 40 ms from end of Inspiration  
 time and during 100 ms from each start  
 of Expiration time. In SIMV Modes the  
 first (one) inspiration started within each  
 SIMV cycle is a mandatory breath.

(S) Initiation of the Start up procedure (with  
 repeat restriction as described in the  
 block part 6.1.1 ...PRVC and VS mode).

(T) Initiation of the Start up procedure (with  
 repeat restriction as described in the  
 block part 6.1.1 ...PRVC and VS mode).

(V) Start of Inspiration time.

- (0) When using Pause time [in Volume control or SIMV (Volume control) mandatory breath]:  
Start of Pause time.  
Else: Start of Expiration time.
- (1) - (6) Start of Expiration time.
- (7) If (8) is true: Start of Pause time  
(or if preset Pause time = 0: Start of Expiration time).  
Else: Change back to Flow regulation.  
This "else" reaction is inhibited by the block 6.1 MODE CPU during 40 ms from the moment of time when (D) is used to change to "On demand flow".
- (8)-(13) Start of Expiration time.  
(9) represents a technical safety function.

The above mentioned conditions, which are used in the block 6.1 MODE CPU, are monitored in the following blocks:

- (B) 2.1 PANEL CPU
- (D) 6.2 PATIENT TRIGGER
- (M) 6.1 MODE CPU
- (P) 6.2 PATIENT TRIGGER
- (S) 2.1 PANEL CPU
- (T) 6.1 MODE CPU
- (V) 6.1 MODE CPU

- (1) - (2) 6.3 End inspiration indicator
- (3) 4.1 MONITOR/ALARM CPU. (MON DIS INSP VALVES.L signal)
- (4) - (5) 6.1 MODE CPU
- (6) 6.3 END INSPIRATION INDICATOR
- (7)-(13) 6.1 MODE CPU

### Additional timing conditions applicable for SV 300A

As long as the front panel setting for **Automode** is in position **Off** and also immediately after switching the front panel setting for Automode into position Off the function of the ventilator with the Mode selector in one of the positions:

1. Pressure Control/Support
2. Volume Control/Support
3. Press. Reg. Vol. Control/Support

is identical to what is described (block 6.1.1) for SV 300 Mode selector positions

1. Pressure Control
2. Volume Control
3. Pressure Reg. Volume Control.

When the front panel setting for **Automode** is in position **On** the function of the ventilator can switch between performing above mentioned Control mode and performing the following corresponding Support mode (according to description in the block 6.1.1):

1. Pressure Support
2. Volume Support
3. Volume Support.

The switch over from any of the 3 Control modes to its above mentioned corresponding Support mode will take place at the following condition:

When the start condition (P) Patient trigger occurs

*and*

The two preceding inspirations were both started by the same start condition (P).

The automatic switch back from above mentioned Support mode to its corresponding Control mode will take place at the following condition:

In the moment when the time duration since last foregoing Patient trigger (P) reaches the following value (depending on the front panel setting for Patient range):

Adult: 12 s

Pediatric: 8 s

Neonate: 5 s.

## 6.2 Patient trigger

This block determines if a signal INTERNAL PATIENT TRIG should be sent to the block 6.1 MODE CPU in order to start a new breath.

The signal is depending on

- Set PEEP value (PEEP LEVEL)
- Set Trigg. sensitivity value (TRIGG. SENSITIVITY)
- Difference between inspiratory flow (INSP FLOW) and expiratory flow (EXP FLOW)
- Expiratory pressure (EXP PRESSURE).

During expiration time (INSP FLOW is kept constant and) the difference  $\text{INSP FLOW} - \text{EXP FLOW}$  is monitored in this block. This difference is positive if EXP FLOW is less than INSP FLOW (which is the case if the patient is inhaling).

Conditions at which the trigger signal PATIENT TRIG is activated:

- When the front panel setting Trigger sensitivity below PEEP is set within its scale between 0 and -17 mbar a trigger signal is generated if the mentioned flow difference reaches a level equal to INSP FLOW and at the same time the EXP PRESSURE signal reaches down to the trigger level (pressure level). The trigger level is calculated from the front panel settings for PEEP and Trigger sensitivity below PEEP (according to the knob scale).
- When the front panel setting Trigger sensitivity below PEEP is set to a certain *part* from the right end within the colour marked range, a trigger signal is generated if the mentioned flow difference reaches a level equal to corresponding *part* of the INSP FLOW.

The generated trigger signal is filtered by the block 6.1 MODE CPU and then used as trigger signal to immediately start the next inspiration. This is simultaneously indicated by two yellow LEDs flashing at the right low end of the front panel pressure bargraph.

## 6.3 End inspiration indicator

During inspiration time when pressure regulation is used, except in Pressure Control mode or mandatory breaths in SIMV(Press. Control) mode, the moment when the inspiration is about to stop is normally determined in this block (a START EXP signal is generated). Thus this block determines when a signal, INTERNAL START EXP.H, should be sent to the block 6.1 MODE CPU in order to start an expiration.

This output signal is depending on:

- Expiratory pressure (EXP PRESSURE).
- Inspiratory flow (INSP FLOW)
- PRESSURE REGULATION PRESSURE REF (N43:B3).

## 6.4 Pressure PID control

For pressure regulation the INSP PRESSURE signal from the pressure transducer in the main block 12 INSPIRATORY PRESSURE is used as actual value in this controller block.

PRESSURE REGULATION PRESSURE REF signal is used by the PRESSURE PID CONTROL as reference for the pressure. Additionally the EXP PRESSURE signal from the pressure transducer in the main block 13 EXPIRATORY PRESSURE is used to adjust this reference level for the pressure. This adjustment - a compensation for pressure drop in the inspiratory airway- is to achieve a resulting pressure level in the patient system - generated via the main blocks 8 and 9 (Inspiratory valve units) - equal to PRESSURE REGULATION PRESSURE REF ( $= P_{REF}$ ) as measured by the block 13.2 PRESSURE TRANSDUCER for Expiratory pressure. This normally results in a pressure level at the Y-piece (= close to the patient) which corresponds to settings on the main block 1 FRONT PANEL even if there is a pressure drop in the inspiratory tubing between the block 11.1 INSPIRATORY MIXING PART and the Y-piece (for example when using an active humidifier). Such a pressure

drop up to 15 cm H<sub>2</sub>O is compensated in this way.

The actuating signal from the PRESSURE PID CONTROL output is used by the block 7.3 MIXER as reference for the total flow (PRESSURE REGULATION FLOW REF).

## 6.5 I/O

This block is an interface for the input and output signals (to and from this PC-board).

Example of output:

Disabling signals for inspiratory valves (ZEROING INSP VALVES).

7 Inspiratory control

This main block consists of the board PC 1616 INSPIRATORY CONTROL including its MICROPROCESSOR MODULE PC 1588.

7.1 Mixer CPU including MIX-PROM functions

This block includes the board PC 1588 with a MIX-PROM. Some details of the Micro-processor module PC 1588 are mentioned in section General in this chapter. The MIX-PROM function is a control function for the block 7.3 MIXER.

FLOW REF overrange

The overrange indication signal OVERRANGE.H (going to the block 4.1 MONITOR/ALARM CPU) is activated in case the level of the input signal FLOW REF is above 9.9 V during more than 50% of the duration of one Inspiration time or during more than 200 ms.

Since the scale factor of the FLOW REF signal is 3/18/45 V/l/s (Adult/Pediatric/Neonate) this implies a limit value for the flow reference signal FLOW REF concerning overrange indication as shown in the following table:

Patient range setting	Overrange condition
Adult	FLOW REF > 3.3 l/s
Pediatric	FLOW REF > 0.55 l/s
Neonate	FLOW REF > 0.22 l/s

7.2 Inputs

This block is a multiplexor for input signals to the main block 7 INSPIRATORY CONTROL.

Example of input:

- Front panel setting for O<sub>2</sub> concentration (O<sub>2</sub> CONC SETTING).

7.3 Mixer

Input signals used in this block are:

- O<sub>2</sub> CONC SETTING (From main block 1 FRONT PANEL)
- One of the two flow reference signals (from main block 6 REFERENCE & TIMING)

Controlled by the block 7.1 MIXER CPU the flow reference signal in use is split up into partial flow reference signals used in the main blocks 8 INSPIRATORY VALVE UNIT – AIR and 9 INSPIRATORY VALVE UNIT – O<sub>2</sub>:

- AIR FLOW REF *and*
- O<sub>2</sub> FLOW REF

The sum of these reference level signals (internal signal TOT. FLOW REF) corresponds to the flow reference input signal in use.

When the function Oxygen breaths is activated – from main block 1 FRONT PANEL – the O<sub>2</sub> CONCENTRATION value used for the split up of the flow reference signal in this block 7.3 MIXER is 100% during 20 breaths or during 1 minute (whichever represents the shorter time).

## Patient unit – Pneumatic section

The Pneumatic section consists of the main blocks 8 – 19 which are described below.

A "mother" board, PC1607 PNEUMATIC INTERCONNECTION, provides signal connections via connectors (but no electronic functions).

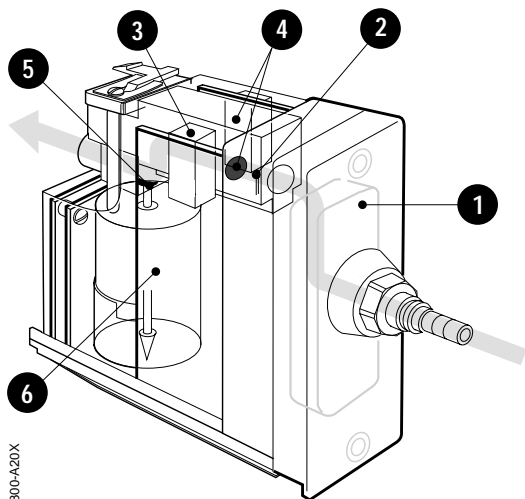
2

## 8 Inspiratory valve unit – Air

The inspiratory valve units for AIR and O<sub>2</sub> are factory calibrated.

The adjustment potentiometer which is situated at the top of each inspiratory valve unit *must not* be adjusted

Each inspiratory valve unit *must not* be disassembled further than described in the Operating Manual, chapter 3000 hours overhaul.



1. Bacteria filter
2. Inspiratory valve temperature sensor
3. Supply pressure transducer
4. Flow transducer (Delta pressure transducer and net)
5. Nozzle unit with valve diaphragm
6. Inspiratory solenoid with position sensor

## 8.1 Air inlet

The air inlet nipple is a quick-coupling where compressed air is connected to the ventilator. The design of the air inlet nipple and the colour marking ring varies according to the standard chosen.

A non-return valve for the air inlet is located in the inlet filter cover, see 8.2 BACTERIA FILTER.

## 8.2 Bacteria filter

The BACTERIA FILTER protects the ventilator from bacteria and particles in the gas delivered to the air inlet. Service interval 3000 h of operation for exchange of the inspiratory valve unit BACTERIA FILTER.

The filter housing and the filter cover is provided with matching guide pins. These guide pins will make it impossible to mount the filter cover (with inlet nipple) on wrong inspiratory valve unit.

A non-return valve for the gas inlet is located in the inlet filter cover. This valve will suppress short pressure drops in the gas supply.

The non-return valve is also designed to slowly evacuate compressed gas from the inspiratory valve unit if the gas supply to the ventilator is disconnected.



### 8.3 Inspiratory valve temperature sensor

The temperature of the supplied gas is measured by the INSPIRATORY VALVE TEMPERATURE SENSOR. This sensor is a part of PC 1637 and it is situated in the gas flow.

The output signal from this sensor is used in 8.13 DELTA PRESSURE AMPLIFIER to compensate for gas temperature variations.

### 8.4 Supply pressure transducer

The pressure of the supplied gas is measured by the SUPPLY PRESSURE TRANSDUCER.

The output signal from this transducer is amplified in 8.10 PRESSURE AMPLIFIER and then used in 8.11 PRESSURE CALCULATOR to calculate the absolute pressure of the gas.

### 8.5 Delta pressure transducer and net

The gas flows through a net (resistance) which causes a pressure drop. The pressure is measured on both sides of this net and the differential pressure value is then amplified in 8.13 DELTA PRESSURE AMPLIFIER.

### 8.6 Nozzle unit

The NOZZLE UNIT contains an O-ring and a valve diaphragm. The valve diaphragm, controlled by the 8.7 INSPIRATORY SOLENOID, regulates the gas flow through the inspiratory valve unit.

Service interval 3000 h of operation for exchange of the valve diaphragm and O-ring. After replacement, allow the diaphragm to settle during approx. 10 minutes before gas pressure is connected to the inspiratory valve unit.

### 8.7 Inspiratory solenoid with position sensor

The gas flow through the INSPIRATORY VALVE UNIT is regulated by the INSPIRATORY SOLENOID via the 8.6 NOZZLE UNIT.

The solenoid receives power from the block 8.22 CURRENT POWER. The current supplied to the solenoid is regulated so that the inspiratory valve unit will deliver a gas flow according to the front panel settings.

An optical sensor on the board PC 1593 POSITION SENSOR I mounted at the bottom of the inspiratory solenoid detects its position and the resulting INSP. VALVE POSITION signal is used in the block 8.20 POSITION PD CONTROL.

### 8.8 Valve code transponder

The inspiratory valve units are provided with an electrical code that states the valve type (AIR, O<sub>2</sub>, etc). This valve type information is transmitted back via the 15 VALVE CONTROL to the 7.1 MIXER CPU if required by the 7.1 MIXER CPU.

The VALVE CODE TRANSPONDER handles this serial communication between the inspiratory valve unit and the 7.1 MIXER CPU.

### 8.9 Inspiratory valve key

The inspiratory valve units are provided with a mechanical key, INSPIRATORY VALVE KEY, to prevent that the inspiratory valve unit is mounted in the wrong slot.

The valve key consists of a plastic guide mounted underneath the inspiratory valve unit and a corresponding guide mounted on the pneumatic section base.

## 8.10 Pressure amplifier

The PRESSURE AMPLIFIER amplifies the input signal from 8.4 SUPPLY PRESSURE TRANSDUCER. The output signal from this amplifier, representing the relative gas supply pressure, is used in:

- 8.11 PRESSURE CALCULATOR to calculate the absolute pressure of the gas
- 8.12 SUPPLY PRESSURE AMPLIFIER.

## 8.11 Pressure calculator

The PRESSURE CALCULATOR calculates the sum of:

- Gas pressure (input from 8.10 PRESSURE AMPLIFIER) and
- Barometer pressure (input from 4.6 BAROMETER PRESSURE TRANSDUCER).

The result of this calculation is the absolute pressure of the gas.

Output signals from the pressure calculator are used in:

- 8.15 FLOW CALCULATOR
- 8.18 VALVE POSITION CALCULATOR.

## 8.12 Supply pressure amplifier

The relative gas supply pressure, input signal from 8.10 PRESSURE AMPLIFIER, is amplified in the SUPPLY PRESSURE AMPLIFIER.

Output signals from this block is used in:

- 4 MONITORING to show the corresponding relative gas supply pressure on the front panel
- 8.13 DELTA PRESSURE AMPLIFIER.

## 8.13 Delta pressure amplifier

The input signal from 8.5 DELTA PRESSURE TRANSDUCER is amplified in the DELTA PRESSURE AMPLIFIER. The output signal is influenced by the relative gas supply pressure value from 8.12 SUPPLY PRESSURE AMPLIFIER as well as from 8.3 INSPIRATORY VALVE TEMPERATURE SENSOR.

The potentiometer at the top of the INSPIRATORY VALVE UNIT implies a limited (approx.  $\pm 3\%$ ) adjustment possibility of this signal. This signal is not a directly proportional part of the flow and *no* service adjustment must be made. If the INSPIRATORY VALVE UNIT proves to be out of specification it is recommended -for safety reason- to exchange it.

The output signal is used in 8.15 FLOW CALCULATOR.

## 8.14 Zero offset

The possible offset of the pressure drop signal, measured by 8.5 DELTA PRESSURE TRANSDUCER, is set to zero in the beginning of each breath cycle, i. e. when the flow through the inspiratory valve is zero.

The block ZERO OFFSET delivers an offset compensation voltage to 8.13 DELTA PRESSURE AMPLIFIER. The zeroing function is controlled from 15.4 VALVE ZEROING.

## 8.15 Flow calculator

The flow depending signal from 8.13 DELTA PRESSURE AMPLIFIER and the absolute supply pressure depending signal from 8.11 PRESSURE CALCULATOR are used to generate a linearized actual gas flow signal (AIR FLOW).

This flow signal is a flow measurement referenced to standard barometric pressure (1013 mbar, 760 mm Hg). For conversion to ambient pressure, see section "Conversion for flow and volume to achieve reference to ambient pressure" in the Operating Manual.

## 8.16 Flow I control

Controller block comparing actual AIR FLOW and desired AIR FLOW REF. The actuating output signal is used to influence the block 8.17 COMPENSATION  $\pm 5\%$ .

## 8.17 Compensation $\pm 5\%$

The output signal corresponds to the input signal AIR FLOW REF with an adjustment controlled by the block 8.16 FLOW I CONTROL. The adjustment (compensation) is limited to a maximum of 5%.

## 8.18 Valve position calculator

This function is an additional compensating element for the regulation where the actual absolute supply pressure value from the block 8.11 PRESSURE CALCULATOR and the desired AIR FLOW REF signal compensated in the block 8.17 COMPENSATION  $\pm 5\%$  generate an activating signal which is used as a basic reference for POSITION of the inspiratory valve.

## 8.19 Flow PI control

Controller block comparing actual AIR FLOW from the block 8.15 FLOW CALCULATOR with desired AIR FLOW REF signal compensated in the block 8.17 COMPENSATION  $\pm 5\%$ . The actuating output signal is added as a final adjustment to the basic position signal from the block 8.18 VALVE POSITION CALCULATOR generating the desired POSITION REF signal for the block 8.20 POSITION PD CONTROL.

## 8.20 Position PD control

Controller block comparing actual INSP. VALVE POS. value from the position sensor in the block 8.7 INSPIRATORY SOLENOID WITH POSITION SENSOR and desired POSITION REF signal mentioned in the block 8.19 FLOW PI CONTROL. The actuating output signal (together with a signal compensating for the supply pressure) is used as the desired INSP. VALVE CURRENT REF signal in the block 8.21 CURRENT CONTROL.

## 8.21 Current control

Consists of the board PC 1585 CURRENT CONTROL.

Controller block regulating the current going to the block 8.7 INSPIRATORY SOLENOID WITH POSITION SENSOR according to the desired input signal IINSP. VALVE CURRENT REF from the block 8.20 POSITION PD CONTROL. The actuating output signal is a pulse train with constant frequency of 30 kHz and pulse width modulation used in the block 8.22 CURRENT POWER.

## 8.22 Current power

Consists of the board PC 1586 CURRENT POWER.

Driving stage for the energy going to the block 8.7 INSPIRATORY SOLENOID WITH POSITION SENSOR. The result of the output signal is a certain opening of the INSPIRATORY VALVE.

## 9 Inspiratory valve unit – O<sub>2</sub>

The INSPIRATORY VALVE UNIT – O<sub>2</sub> works in the same way as the 8 INSPIRATORY VALVE UNIT – AIR. The Description of functions is valid for both types of inspiratory valve units.

There are, however, some differences in the design of the different valve units:

- The electrical code that states the valve unit type, see 8.8 VALVE CODE TRANSPONDER
- The mechanical code that states the valve unit type, see 8.9 INSPIRATORY VALVE KEY
- A strapping on PC 1602 to change the linearization, see 8.15 FLOW CALCULATOR
- A different inlet nipple, see 9.1 O<sub>2</sub> INLET.

### 9.1 O<sub>2</sub> inlet

The O<sub>2</sub> inlet nipple is a quick-coupling where O<sub>2</sub> is connected to the ventilator. The design of the O<sub>2</sub> inlet nipple and the colour marking ring varies according to the standard chosen.

A non-return valve for the O<sub>2</sub> inlet is located in the bacteria filter cover, see 8.2 BACTERIA FILTER.

## 10 Inspiratory valve unit – Optional

If the third valve slot is not used for equipment for e. g. NO gas administration or nebulizing drugs, a valve dummy without valve function must be mounted in the third valve slot on the ventilator.

It contains one electronic board PC 1634 DUMMY VALVE CONNECTION. It responds internally as a 8.8 VALVE CODE TRANSPONDER indicating that this valve function is not available.

It is also provided with a mechanical code. See 8.9 INSPIRATORY VALVE KEY.

As mentioned above, the valve dummy can be replaced by an inspiratory valve for administration of e. g. NO gas or by equipment for nebulizing drugs (Servo Ultra Nebulizer 345). These products are described in separate documents.

## 11 Inspiratory channel

The fresh gas from the INSPIRATORY VALVES (8 and 9) is mixed and lead to the patient system via this channel. The O<sub>2</sub> cell and the safety valve are also parts of the inspiratory channel.

### 11.1 Inspiratory mixing part

The different fresh gases come together in this part. It also contains a fitting which connects to the main block 12 INSPIRATORY PRESSURE.

The INSPIRATORY MIXING PART is designed to suppress pressure oscillates from going to the pressure transducer.

### 11.2 Inspiratory pipe

This plastic pipe leads the mixed gas from the 11.1 INSPIRATORY MIXING PART to the patient system. It is held in position by a snap lock.

It contains a holder for the 11.3 O<sub>2</sub> CELL and it is integrated with the 11.4 SAFETY VALVE seat. The outlet of this inspiratory pipe is called INSPIRATORY OUTLET.

### 11.3 O<sub>2</sub> cell

The O<sub>2</sub> cell is mounted in a holder on the 11.2 INSPIRATORY PIPE and protected by a bacteria filter. Service interval 3000 h of operation for exchange of the O<sub>2</sub> BACTERIA FILTER.

The O<sub>2</sub> cell gives an output voltage proportional to the partial pressure of oxygen inside the INSPIRATORY PIPE. At constant pressure this output is proportional to the O<sub>2</sub> concentration in percent. In each O<sub>2</sub> cell the output signal will stay at a fairly constant level usually within 10–17 mV in normal air and standard barometric pressure during the life time of the cell. This signal is used in the block 15.3 O<sub>2</sub> CONCENTRATION AMPLIFIER. The cell should be replaced when the output level has started to decrease. In this situation, repeated calibration of the O<sub>2</sub> concentration is required.

The life time of the cell is affected by the O<sub>2</sub> concentration. With the O<sub>2</sub> concentration (at the cell) in % and expected cell life in hours the following applies at 25°C (77°F):

$$\text{O}_2 \text{ concentration} \times \text{Expected cell life} \approx 800\,000\% \text{ hours.}$$

A separate output signal (O<sub>2</sub> CELL CONNECTED L) indicates if the O<sub>2</sub> cell is connected or not. This signal is used in the main block 4 MONITORING. The O<sub>2</sub> cell cable is connected to the board PC 1607 PNEUMATIC INTERCONNECTION (connector P22) inside the PATIENT UNIT.

## 11.4 Safety valve

The safety valve function depends on its solenoid and on its factory trimmed springs. The solenoid can be electrically activated only from the 11.5 SAFETY VALVE DRIVER. When the valve is opened it connects the INSPIRATORY PIPE directly to ambient air thus enabling a decrease in pressure. The valve can open in two different ways.

1. When the solenoid is not activated (via the SAFETY VALVE DRIVER) the mechanical spring which is built into the solenoid pushes the solenoid axis upwards. This actuates the safety valve to be opened. This is normal safety (pop off) function. This is also the case when the MODE SELECTOR is set at Ventilator Off.
2. The two springs which hold the safety valve disc in position are factory trimmed to a tension such that the SAFETY VALVE will let out gas if the pressure inside the INSPIRATORY PIPE should exceed 120 cm H<sub>2</sub>O (even if the solenoid is activated). This is an extra safety function, and the situation will normally not occur.

During start up, the solenoid is electrically activated so that the solenoid axis is pulled down (with a clicking sound). This is the normal operational position of the solenoid; the SAFETY VALVE is normally kept closed.

## 11.5 Safety valve driver

The SAFETY VALVE DRIVER consists of the electronic board PC 1613 with three connection cables:

- It is connected (at the connector P53) via a cable to the 21 POWER SUPPLY. The safety valve is protected by a PTC resistor in the 21 POWER SUPPLY.
- It is connected (at N54) via a cable to the board PC 1607 PNEUMATIC INTERCONNECTION (connector P23).
- It is connected (at N55) via a cable to the 11.4 SAFETY VALVE solenoid. The function of this block is to provide power to the SAFETY VALVE solenoid controlled, by the input signal DIS SAF VALVE AND 24V (via P54:3) from the main block 4 MONITORING.

## 12 Inspiratory pressure

The function of this main block is to measure the pressure in the 11 INSPIRATORY CHANNEL and generate a corresponding signal INSP. PRESSURE via the board PC 1607 PNEUMATIC INTERCONNECTION (N24:C7) to the main blocks 4 MONITORING and 6 REFERENCE & TIMING.

### 12.1 Bacteria filter

This filter protects the 12.2 PRESSURE TRANSDUCER on the board 12.3 PRESSURE AMPLIFIER from contamination.

Service interval 3000 h of operation for exchange of the inspiratory pressure BACTERIA FILTER.

### 12.2 Pressure transducer

This differential PRESSURE TRANSDUCER is an integrated part of the board 12.3 PRESSURE AMPLIFIER mounted together with a silicon rubber connection piece. It refers the pressure to ambient pressure and gives a linear measurement in the range  $-20 \text{ cm H}_2\text{O}$  to  $+120 \text{ cm H}_2\text{O}$ .

Pressure exceeding  $\pm 200 \text{ cm H}_2\text{O}$  must be avoided.

### 12.3 Pressure amplifier

This board PC 1611 contains:

- a pressure transducer
- a generator of +5V REFERENCE VOLTAGE
- an amplifier for the pressure signal
- the two potentiometers for calibration of zero offset and gain.

When calibrated according to the Operating Manual, chapter Calibration, the PRESSURE OUT signal (P24:C7) will have a scale factor of  $75 \text{ mV/cm H}_2\text{O}$ .



## 13 Expiratory pressure

The function of this main block is to measure the pressure in the 14 EXPIRATORY CHANNEL and generate a signal EXP. PRESSURE via PC 1607 PNEUMATIC INTERCONNECTION (N25:C7 from P24:C7) to the main blocks 4 MONITORING, 6 REFERENCE & TIMING and 15 VALVE CONTROL.

A recommendation to regularly exchange the 13.1 BACTERIA FILTER with its connection tube and nipple is given in the Operating Manual, chapters Routine cleaning, 1000 hour overhaul and 3000 hour overhaul with complete cleaning.

### 13.1 Bacteria filter

This filter protects the 13.2 PRESSURE TRANSDUCER on the board 13.3 PRESSURE AMPLIFIER from contamination.

Service interval 1000 h of operation for exchange of the inspiratory pressure BACTERIA FILTER. The filter is also replaced during the Routine cleaning.

### 13.2 Pressure transducer

See 12.2

### 13.3 Pressure amplifier

See 12.3

## 14 Expiratory channel

The expiratory channel conveys the expiratory gas from the patient system through the patient unit.

### 14.1 Expiratory inlet with moisture trap

The function of the moisture trap is to reduce the condensation of moisture in the expiratory channel. The gas temperature is first decreased and then increased in order to reduce the condensation before the gas enters the 14.4 EXPIRATORY CONNECTION TUBE.

If moisture is condensated in the moisture trap, it is collected in a plastic container. Empty the plastic container if necessary. When removing the plastic container, a built-in valve closes to keep the patient system tight.

### 14.2 Expiratory connection tube

The inside bottom of this silicon rubber tube has a slope down towards the 14.1 EXPIRATORY INLET WITH MOISTURE TRAP.

### 14.3 Expiratory flow transducer

The gas flows through the expiratory flow transducer in two parallel channels, one large main channel, and one small measuring channel. The main channel is fitted with a wire mesh net, the resistance of which causes a certain proportion of the gas to flow through the measuring channel. The flow through, and the differential pressure across, the measuring channel acts on a small metal disc ("flag"), which, via a metal pin presses on a small semiconductor strain gauge. This consists of diffused resistors on both sides of an elastic silicone rod. The resistors are connected as a part of a Wheatstone bridge, the other part of which

is situated on the 14.4 EXPIRATORY FLOW AMPLIFIER. The more flow in the channel, the higher the pressure on the strain gauge. The change in resistance in the Wheatstone bridge is converted to a corresponding signal voltage.

A resistor, 220 Ohms, 6W, is moulded into the transducer and is used for heating of the expiratory flow transducer. The transducer is heated to approximately 40°C (104°F) to prevent condensation of water vapour. The heating is controlled from the main block 18 EXP. FLOW LINEARIZATION. If water should condense in the expiratory flow transducer, the resistance of the wire mesh net increases. Thus the output signal will increase. This can be seen on the digital display and the bargraph for EXPIRED MINUTE VOLUME, as an increased reading. The accumulation of medicaments, mucus and secretion in the expiratory flow transducer gives the same result.

For details on cleaning and calibration of the flow transducer, see the chapters Routine cleaning and Calibration in the Operating Manual. Service interval 1000 h of operation for exchange of the wire mesh net.

## 14.4 Expiratory flow amplifier

This block consists of the board PC 1623 EXPIRATORY FLOW AMPLIFIER with its plastic housing and the expiratory flow connection cable.

Two potentiometers and a green indicator LED are used when calibrating the flow signal according to chapter Calibration in the Operating Manual.

The change in resistance in the 14.3 EXPIRATORY FLOW TRANSDUCER is converted to a corresponding signal voltage. This signal, a non-linear function of the flow, is handled in the main block 18 EXP. FLOW LINEARIZATION.

A temperature sensor mounted close to the 14.3 EXPIRATORY FLOW TRANSDUCER measures its temperature. The signal TEMP SENSOR is used by the TRANSDUCER TEMPERATURE CONTROL block in the main block 18 EXP. FLOW LINEARIZATION.

The connector (N30) at the end of the expiratory flow connection cable can be disconnected from the 18 EXP. FLOW LINEARIZATION (PC 1615: N30). Thus an extra 14 EXPIRATORY CHANNEL can be calibrated and ready for use, but only in the ventilator it has been calibrated in.

## 14.5 Expiratory valve tube

This tube connects the 14.3 EXPIRATORY FLOW TRANSDUCER with the 14.6 EXPIRATORY OUTLET. It is mounted on a holder pin and it contains a fitting which connects via a nipple to the main block 12 EXPIRATORY PRESSURE. The EXPIRATORY VALVE TUBE is squeezed between the metal bars of the 16 EXPIRATORY VALVE.

Service interval 1000 h of operation for exchange of the EXPIRATORY VALVE TUBE.

## 14.6 Expiratory outlet with non-return valve

The gas from the patient system leaves the ventilator via this outlet. It contains a non-return valve. Its rubber membrane is mounted on a valve seat disc which can be removed from the expiratory outlet.

## 15 Valve control

This main block consists of the board PC 1622 VALVE CONTROL.

### 15.1 PEEP PID control

Controller block comparing actual EXP. PRESSURE signal from the main block 13 EXPIRATORY PRESSURE with desired PEEP LEVEL signal according to front panel setting.

In order to somewhat decrease the expiratory resistance at high expiratory flows, the EXP. FLOW signal from the block 18.5 GAS COMPOSITION COMPENSATION is used in addition to the actual EXP. PRESSURE value in such a way that a high EXP. FLOW value results in a somewhat bigger opening of the EXPIRATORY VALVE compared to when the EXP. FLOW value is small.

The actuating output signal is used as a desired POSITION REF signal for the block 15.2 POSITION PD CONTROL.

### 15.2 Position PD control

Controller block comparing actual EXP. VALVE POSITION signal from the block 16.3 EXPIRATORY SOLENOID WITH POSITION SENSOR with desired POSITION REF signal from the block 15.1 PEEP PID CONTROL. The actuating output signal is used as desired EXP. VALVE CURRENT REF for the block 16.1 CURRENT CONTROL.

### 15.3 O<sub>2</sub> concentration amplifier

This block, the O<sub>2</sub> CONCENTRATION AMPLIFIER, amplifies the signal from 11.3 O<sub>2</sub> CELL.

The output signal is amplified to 90 mV/%O<sub>2</sub> at 1013 mbar (760 mmHg) ambient barometric pressure. This output signal is used in:

- 4 MONITORING to monitor the O<sub>2</sub> concentration where it is distributed to 1.5 O<sub>2</sub> CONCENTRATION to display the measured value on the front panel.
- 18.1 LINEARIZING CPU for compensation of the EXP. FLOW value.

### 15.4 Valve zeroing

Zero offset is handled through:

- Timing control for the zeroing of the actual gas flow and position signals within the main blocks 8 INSPIRATORY VALVE UNIT – AIR and 9 INSPIRATORY VALVE UNIT – O<sub>2</sub> when the real actual gas flow is zero (normally during pause time).
- Timing control for the zeroing of the actual position signal within the main block 16 EXPIRATORY VALVE.

The timing control mentioned above is executed in cooperation with the block 15.5 VALVE ENABLING.

### 15.5 Valve enabling

Valve enabling/disabling is handled through:

- Timing control (enabling) of the main blocks 8 INSPIRATORY VALVE UNIT – AIR and 9 INSPIRATORY VALVE UNIT – O<sub>2</sub>.
- Timing control (disabling) of the main block 16 EXPIRATORY VALVE.

## 16 Expiratory valve

The function of this main block is to squeeze the 14.5 EXPIRATORY VALVE TUBE in a regulated way.

### 16.1 Current control

Consists of the board PC 1585 CURRENT CONTROL.

Controller block regulating the current going to the block 16.3 EXPIRATORY SOLENOID WITH POSITION SENSOR according to the desired input signal EXP. VALVE CURRENT REF from the block 15.2 POSITION PD CONTROL. The actuating output signal is a pulse train with constant frequency of 30 kHz and pulse width modulation used in the block 16.2 CURRENT POWER.

### 16.2 Current power

Consists of the board PC 1586 CURRENT POWER.

Driving stage for the energy going to the block 16.3 EXPIRATORY SOLENOID WITH POSITION SENSOR. The result of the output signal is a certain opening of the EXPIRATORY VALVE.

### 16.3 Expiratory solenoid with position sensor

The EXPIRATORY SOLENOID controls the opening through the 14 EXPIRATORY CHANNEL by squeezing the 14.5 EXPIRATORY VALVE TUBE to desired position.

The solenoid receives power from the block 16.2 CURRENT POWER. The power supply to the solenoid is regulated so that the remaining pressure in the patient system towards the end of the expiration time is kept on the PEEP level according to front panel setting.

An optical sensor on the board PC 1594 POSITION SENSOR E mounted at the bottom of the expiratory solenoid detects its position and the resulting EXP. VALVE POSITION signal is used in the block 15.2 POSITION PD CONTROL. Offset zeroing for the EXP. VALVE POSITION signal is controlled from the 6.1 MODE CPU via the block 15.4 VALVE ZEROING.

## 17 Optional interface

Not used in this version.

## 18 Expiratory flow linearization

This main block consists of the board PC 1615 EXP. FLOW LINEARIZATION. The purpose of this main block is to linearize the output signal for expiratory flow.

### 18.1 Linearizing CPU including LIN-PROM functions

The LINEARIZING CPU will calculate a compensation factor for the flow output signal (EXP. FLOW). This compensation depends on:

- Gas composition (O<sub>2</sub> concentration)
- Expiratory pressure
- Barometric pressure.

### 18.2 Transducer temperature control

The block TRANSDUCER TEMPERATURE CONTROL uses the temperature signal (TEMP. SENSOR) from the 14.4 EXPIRATORY FLOW AMPLIFIER to regulate the temperature in the 14.3 EXPIRATORY FLOW TRANSDUCER by controlling the current to its heating resistor.

### 18.3 Zero offset

Automatic zeroing of the unlinear flow signal from the 14.4 EXPIRATORY FLOW AMPLIFIER is made every breath when the actual real expiratory flow is zero (during inspiration time).

### 18.4 Expiratory flow linearizer

Analog linearizing circuit using the unlinear flow signal from the 14.4 EXPIRATORY FLOW AMPLIFIER generating a linear signal representing the measured expiratory flow. This signal is used by the block 18.5 GAS COMPOSITION COMPENSATION.

### 18.5 Gas composition compensation

The measured expiratory flow signal from the block 18.4 EXPIRATORY FLOW LINEARIZER is adjusted for the contents of oxygen and for the ambient pressure resulting in the output signal EXP. FLOW. This limited adjustment function is controlled by the block 18.1 LINEARIZING CPU.

The resulting flow signal is a flow measurement referenced to standard barometric pressure (1013 mbar, 760 mm Hg). For conversion to ambient barometric pressure, see section "Conversion of flow and volume to get reference to ambient pressure" in the Operating Manual.

2

19 Cooling system

19.1 Cooling fan

The COOLING FAN is an axial fan for 24 V power supply.

If the air temperature inside the power section exceeds approx. 41°C (106°F), the 21.4 POWER TEMPERATURE CONTROL will turn on the fan.

The airstream provided by the fan will ventilate (cool) the inside of the patient unit. The airstream is divided so that 70% goes to the power section and 30% goes to the pneumatic section.

When the temperature drops below approx. 40°C (104°F), the fan is automatically turned off.

If the input FAN CONTROL on N78 is connected to ground (CGND), the fan will be on continuously. This option can also be used to test the fan.

19.2 Air inlet with dust filter

There is one AIR INLET WITH DUST FILTER situated on the pneumatic section casing. The dust filter is a fine wire mesh net that provides filtering of the incoming cooling air. Service interval 3000 h of operation for cleaning of the dust filter as described in the Operating Manual.

Patient unit – Power section

The Power section consists of the main blocks 20 – 22 which are described below.

20 Mains power

20.1 Mains power inlet

The MAINS POWER INLET is a male connector at the power section panel. Two fuses (F11 and F12) and a voltage selector are included in the MAINS POWER INLET.

The following table states the voltage selector setting and fuse value for different mains power voltages:

Mains power voltage	Selector setting	Fuses F11/F12
100 V (±10%)	100 V	T 3.15 AL
117 V (±10%)	120 V	T 3.15 AL
220 V (±10%)	220 V	T 1.6 AL
230 V (±10%)	220 V	T 1.6 AL
240 V (±10%)	240 V	T 1.6 AL

Mains frequency is 50 – 60 Hz.

The NTC resistor, soldered to the MAINS POWER INLET, works as an inrush current limiter.

20.2 Transformer

The TRANSFORMER is a toroide transformer rated 235 VA. A temperature fuse, included in the transformer, will blow if the temperature exceeds 110°C (230°F). The fuse is not resetable and not replacable; replace the transformer if the fuse has blown.

20.3 Capacitor

The capacitor shown in this main block is the rectifier smoothing capacitor. The capacitor is rated 40 V DC, 22000 µF.

## 21 Power supply

The power supply, as described below, is all included in PC 1618.

This description refers to PC 1618D. Some functional deviations in older versions of PC 1618 are also described.

Even when the mode selector is set to Ventilator Off, there is still live current on PC 1618:

- +5 V and +24 V if the power source is Mains or an External battery
- +24 V LOW POWER REG if the power source is the Internal battery.

Always disconnect mains power supply as well as external and internal batteries before performing any service intervention on the power section.

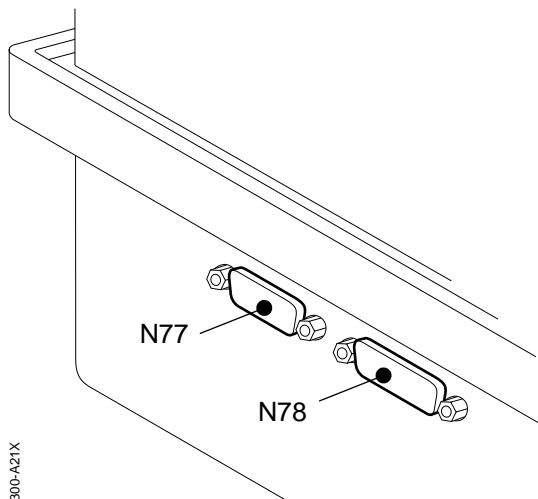
### 21.1 Auxiliary outputs

There are two AUXILIARY OUTPUTS on the power section casing, one 9-pin connector (N77) and one 15-pin connector (N78).

Pin configuration and signal names can be found in chapter "8. Diagrams".

Only accessories, supplies or auxiliary equipment listed in Siemens-Elcoma catalogs ("Products and accessories" Order No. 90 34 562 E323E and "Spare and exchange parts" Order No. 90 34 570 E323E) must be connected to or used in conjunction with the ventilator.

**Warning:** Use of accessories and auxiliary equipment other than those specified in these catalogs may degrade safety and performance of the ventilator.



Note regarding the +24 V PO; At each of these pins at N77 and N78 it is allowed to take out a maximum of 3 A. However, the total current from these pins is not allowed to be more than 4 A altogether.

As indicated by the signal name, all control signals are buffered which makes each output pin short-circuit proof.

The power supply +24 V PO at N77 and N78 is disconnected if:

- The ventilator runs in internal battery mode
- +24 V PO is short circuited
- The power section is overheated, approx. 48°C (118°F).

The power supply (+24 V PO) is automatically reconnected when conditions return to normal.

## 21.2 Voltage distribution

The different voltage levels used in the ventilator are regulated in and distributed from this block. The fuse F1, rated F 6.3 A, limits the total +24 V supply current.

The distributed voltage levels are:

- +24 V: (+24 V FUSED) fused at F2, rated F 1.6 A, via P74
- +24 V: (+24 V) limited at R33, a PTC resistor rated 1.1 A at 20°C, for the 11.4 SAFETY VALVE via P73
- +24 V: (+24 V VALVE) from the electronic VALVE POWER SWITCH via P74
- +24 V: (+24 V LOW POWER REG) used only in the mode selector via P70
- +24 V: (+24 V PO) unregulated voltage, 21 – 34 V, via the auxiliary outputs N77 and N78
- +15 V: (V+) regulated in the DC/DC CONVERTER via P74
- -15 V: (V-) regulated in the DC/DC CONVERTER via P74
- +5 V: (VC5) regulated in the INTERNAL 5 V REGULATOR and used only internally in PC 1618
- +5 V: (+5 V) regulated in the DC/DC CONVERTER via P74
- +5 V: (+5 VL) regulated in the DC/DC CONVERTER used only in the front panel via P74.

The battery connections are equipped with fuses:

- Internal battery connection is fused at F3, rated F 6.3 A.
- External battery connection is fused at F4, rated F 6.3 A.

The number of fuses on PC 1618 and the location of these fuses can vary depending on the different PC-board versions.

## 21.3 Voltage control & Timing

This block administrates the different power supply sources.

If power supply is lower than the limits stated below, the external battery will automatically be used as power source. If no external battery is connected, the internal battery will be used as power source.

- *Mains* is used as power supply source as long as mains power is connected and the voltage level, detected by the +24 V VOLTAGE DETECTOR, is above 19.2 V.
- *External battery* is used as power supply source:
  - if the external battery voltage level is above 23 V in the moment when it is connected *and*
  - as long as the voltage level in the connected external battery is above 21.5 V.

Older versions of PC 1618:

The 23 V limitation mentioned above does not exist and the external battery voltage level, detected by a EQUIPOTENTIAL DETECTION, must be above 20.25 V.

- *Internal battery* is used as power supply source as long as the internal battery voltage level is above 19.5 V. If the voltage level drops below 19.5 V, no power supply is distributed to the ventilator valves.

Older versions of PC 1618:

The internal battery voltage level, detected by a EQUIPOTENTIAL DETECTION, must be above 18.5 V.

The battery voltage levels can be displayed in the Alarm and Message display on the front panel. The displayed value "Internal" is the charging voltage at the internal battery connection (P72).



## 21.4 Power temperature control

A NTC-resistor on PC 1618 senses the air temperature inside the power section.

If the air temperature inside the power section exceeds approx. 41°C (106°F), the 19.1 COOLING FAN is turned on. When the temperature drops below approx. 40°C (104°F), the fan is turned off.

If the air temperature inside the power section exceeds approx. 48°C (118°F), the +24 V power supply (+24 V PO) to the auxiliary outputs N77 and N78 is disconnected. When the temperature drops below approx. 48°C (118°F), this power supply is reconnected.

## 21.5 Charge control

The internal battery is automatically charged if an external power supply (mains power or external battery) is connected. The front panel LED Charge Int. Batt. indicates if the internal battery is in charge mode. During charge mode, one of the following three different battery charge levels is used:

- **Level 1** if the battery voltage level is below 18 V. The battery is charged with 20 mA. This low battery voltage level may indicate a faulty battery, and the low charge current is selected to prevent damages due to a faulty battery.
- **Level 2** if the battery voltage level is between 18 – 29 V. The battery is charged with up to 500 mA.
- **Level 3** is a trickle charge level that will charge the battery with up to 50 mA to keep the voltage level at approx. 27 V.

The time to recharge a discharged battery can be up to 8 hours.

## 22 Operating power

### 22.1 Internal battery

There are two 12 V sealed lead acid batteries connected in series inside the power section used as an internal 24 V battery for backup purposes. The batteries are rated 12 V, approx. 1.9 Ah.

The internal battery voltage level can be displayed in the "Alarm and Message" display on the front panel.

Service interval approx. 3 years for exchange of the internal batteries. After replacement, allow the batteries to recharge before clinical use of the ventilator.

The lifetime of the internal batteries are reduced if the batteries are used frequently to supply the ventilator with operating power. The batteries should not be recharged more than approx. 130 times to keep stated backup capacity.

### 22.2 External battery inlet

The external battery inlet is a three-pin male connector at the power section panel. The external battery inlet is rated 24 V. When connected, the voltage of the external battery must be within approx. 23 – 30 V.

Pin configuration and signal names can be found in chapter "8. Diagrams".

The external battery will not be charged by the mains power supply.

The external battery voltage level can be displayed in the Alarm and Message display on the front panel.

## 22.3 Operating time meter

The operating time meter on the power section panel is supplied with +5 V. This means that the operating time meter will be activated as long as the DC/DC CONVERTER is enabled, i.e. when the mode selector is set to any other mode than Ventilator Off.

## 23 Interconnection cable

The INTERCONNECTION CABLE is the 2.95 m long 89 leads cable that connects the Control unit with the Patient unit.

Pin configuration and signal names can be found in chapter "[8. Diagrams](#)".

# 2

## 22.4 Grounding terminal

The grounding terminal is a potential equalization pin at the power section panel. All internal grounds as well as protection ground in the mains power inlet are connected to this grounding terminal.

### 3. Disassembling and assembling

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## General

The different main units and sub-units of the Servo Ventilator 300 are described in chapter Introduction. This information can be useful also when disassembling and assembling the Servo Ventilator 300.

Disassembling and assembling of the inspiratory and expiratory channels and of the inspiratory valve units is described in the Operating Manual, chapter Cleaning. A further disassembling and assembling of the ventilator is described in this chapter.

The illustrations in the Siemens-Elema catalog "Spare and exchange parts" (Order No. 90 34 570 E323E) are very useful as a guide when disassembling and assembling the Servo Ventilator 300.

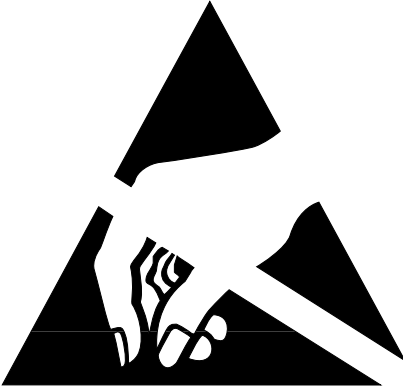
Service equipment (tools, calibration and test equipment) can also be found in the catalog stated above.

### Preparations

Before disassembling or assembling the Servo Ventilator 300, make sure that:

- Gas supply is disconnected
- Mains power cable is disconnected
- Mode selector is set to Ventilator off.  
If the mode selector is set in any other position, the internal battery will supply power to the PC boards
- All gas conveying parts are cleaned according to instructions in the Operating Manual.

After any service intervention in the Servo Ventilator 300, perform a Function check according to instructions in the Operating Manual.



## Handling PC boards

The PC boards contain components that are highly sensitive to static electricity.

Those who come into contact with circuit boards containing sensitive components must take certain precautions to avoid damaging the components (ESD protection).

When working with ESD sensitive components, always use a grounded wrist band and grounded work surface. Adequate service tools must also be used.

PC boards (spare or exchange parts) must always be kept in protective packaging for sensitive electronic device.

PC boards must not be inserted or removed while the mains power or battery power is applied to the PC boards.

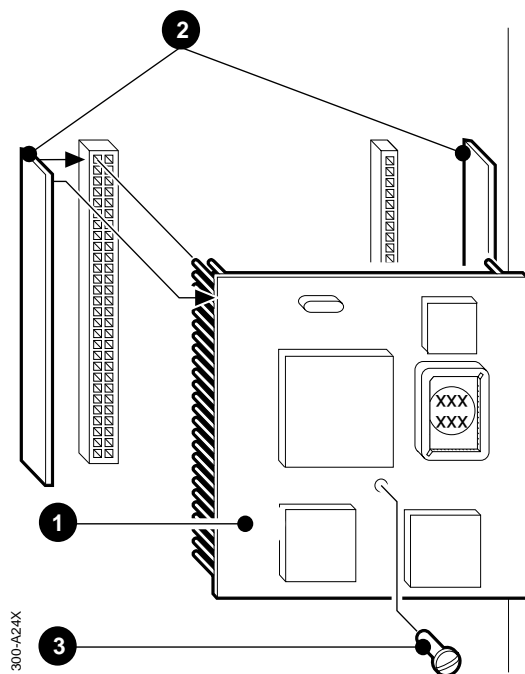
Remove and insert the PC boards very carefully to avoid damage to the connectors.

## Microprocessor module PC 1588

Each one of the five PC boards PC 1605, PC 1608, PC 1614, PC 1615 and PC 1616 includes a microprocessor module. This microprocessor module, PC1588 (1), is mounted with its two rows of connectors into the corresponding connectors on the PC boards mentioned above.

PC 1588 is secured to its corresponding PC board with one of the following methods:

- On older units; strips of glue on the connector sides *or* adhesive tape (2).
- On newer units; screw (3).



## Removing PC 1588

- Remove the securing device (see above). Remove any remaining glue strips on the connector sides
- Carefully lift off PC 1588 from the PC board where it is mounted. Do not damage the connector pins on PC 1588.

## Assembling PC 1588

- Check that no connector pin on PC 1588 is damaged.
- Carefully mount PC 1588 onto the corresponding PC board and make sure that all connector pins fit in the connector socket.
- Secure the PC boards to each other:
  - On older units; non-conductive adhesive tape (2). Do not use glue.
  - On newer units; screw (3).

## Exchanging PROMs

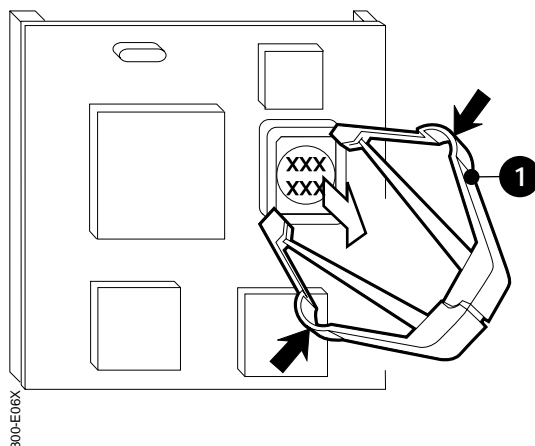
On each of the PC-boards PC 1587 and PC 1588, there are exchangeable program memory modules, PROMs.

The PROMs are denominated and labelled as follows:

- COM-PROM (PC 1587). Divided into two PROM chips
- REF-PROM (PC 1588 on PC 1605)
- MON-PROM (PC 1588 on PC 1608)
- PAN-PROM (PC 1588 on PC 1614)
- LIN-PROM (PC 1588 on PC 1615)
- MIX-PROM (PC 1588 on PC 1616).

A label showing all PROM-versions included in the ventilator is attached to the control section. When replacing a PROM chip, attach the new label (delivered with the PROM) onto the old label on the control section.

**Note** – Before exchanging COM-PROMs, always disconnect the power supply from the battery on PC 1587 COMPUTER INTERFACE. See information regarding power supply disconnection in chapter "4. Service procedures", section "Resetting the trend data memory and real time clock".



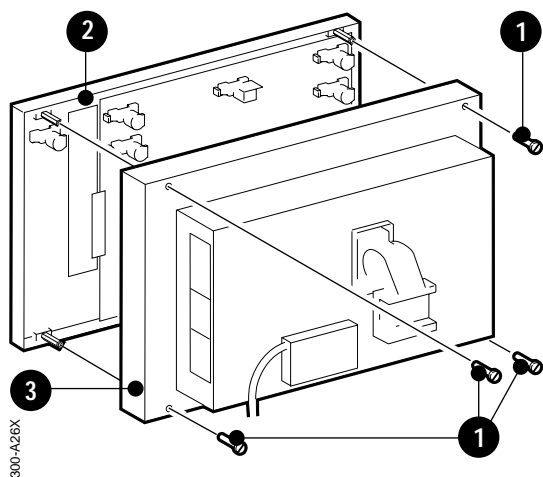
When removing a PROM chip from the PROM socket, always use a PROM extraction tool (1), Order No. 62 04 353 E380E. Do not try to pull the PROM chip out of its socket. Squeeze the pliers and let the tool action pull it out.

Some PC boards have been equipped with PROM socket from a different manufacturer (AMP). The PROM extraction tool stated above do not fit these sockets. For AMP sockets, use the extraction tool, Order No. 20 11 109 E500U, or a PROM extraction tool obtained through your local AMP dealer. For further information, see EM Express "PLCC Surface Mount Sockets" dated 1996-05-21.

## Separating the panel section from the control section

- Remove the four screws (1).
- Carefully lift off the panel section (2).

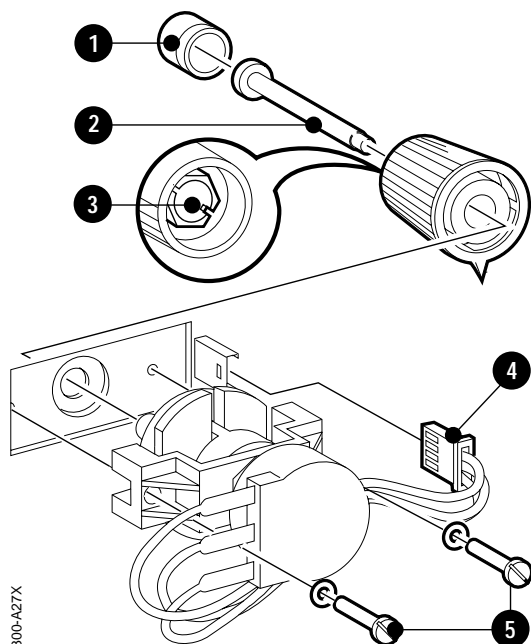
The panel section is now separated from the control section (3).



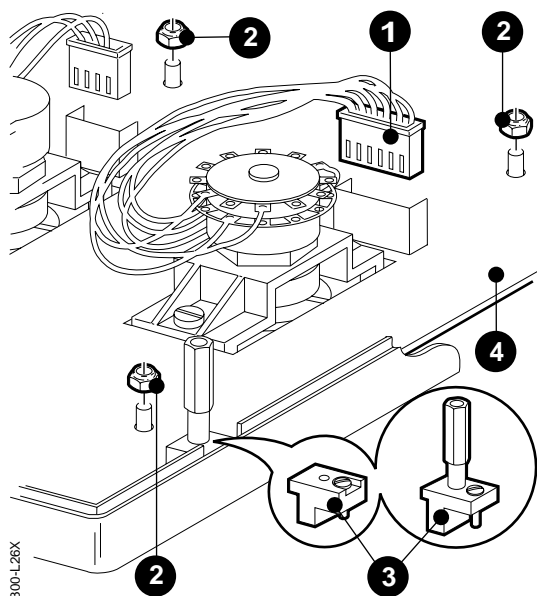
## Disassembling the panel section

### Front panel controls

- Separate the panel section from the control section as previously described.
- Remove the knob cover (1).
- Remove the pin (2) if the control has a push-button release function.
- Loosen the nut (3) holding the knob and lift off the knob from the control shaft. Use the knob holder tool, Order No. 62 04 197 E380E, when removing the control knob.
- Disconnect the connector (4).
- Remove the two screws (5) and lift off the control.







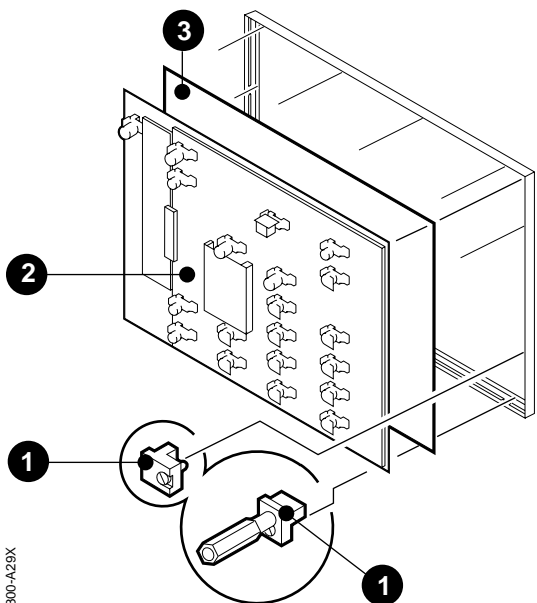
## Panel interface board PC 1614

- Separate the panel section from the control section as previously described.
- Disconnect all front panel control connectors (1) from PC 1614.
- Remove all nuts (2) holding PC 1614.
- On newer units: Remove all panel holders (3).
- Carefully lift off PC 1614 (4) from the front panel base plate.

When the panel interface board PC 1614 is separated from the front panel base plate (e. g. as a spare or exchange part), there are a number of components on PC 1614 that can be easily damaged. Therefore, *always* handle PC 1614 very carefully.

3

## Front panel film



- Separate the panel section from the control section as previously described.
- Remove all front cover control knobs as previously described. Remove only the control knobs, not the complete controls.
- Remove all panel holders (1) that secures the front panel plate to the frame.
- Lift off PC 1614 including the front panel base plate (2).
- Lift off the front panel film (3) from the frame.

## Assembling the panel section

The procedure for assembling the panel section is the reverse of the disassembly procedure previously performed.

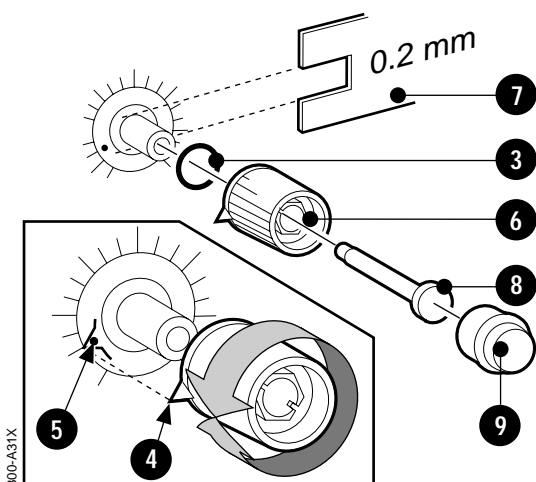
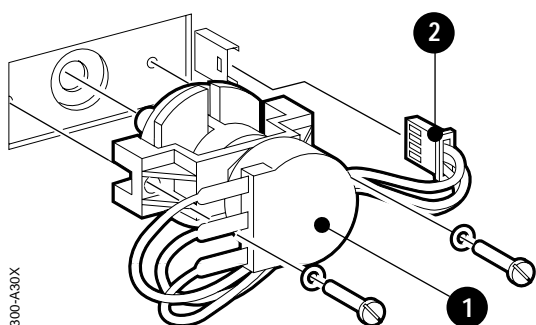
The following points must be noted during assembling:

### Panel interface board PC 1614

- Carefully mount PC 1614 on the front panel base plate. Make sure that the PC boards indicator LEDs and touch sensors fit into the corresponding holes in the front panel base plate.

### Front panel controls

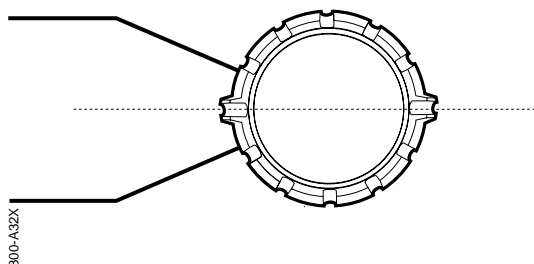
- Mount the control (1) on the front panel base plate and connect the connector (2) to the PC board.
- On older units: Check that there is an O-ring (3) mounted on the knob. On newer units: The knob pointer ring is made of a flexible rubber material that replaces the function of the O-ring. The O-ring is not used.
- Put the knob on the control shaft.
- Adjust the knob so that the knob pointer (4) aligns with the indication mark (5). The indication mark is a small dot or a thin guide line.
- Tighten the nut (6) slightly.
- Check that the knob pointer still aligns with the indication mark.



- Tighten the nut (6). Tighten to approx.:
  - 150 Ncm on the mode selector knob
  - 90 Ncm on all other knobs.

Use the knob holder tool, Order No. 62 04 197 E380E, when mounting the control knob.

- Check that the knob is easy to turn. If the knob is hard to turn, it can be necessary to put a 0.2 mm thickness gauge (7) between the front panel film and the knob while mounting the knob. The thickness gauge Order No. is 61 50 895 E380E.
- Mount the pin (8) and the knob cover (9).



There are three spring-loaded controls on the front panel:

- Oxygen breaths / Start breath
- Reset / 2 min
- Pause hold Insp. / Exp.

These controls do not have the thin guide line mentioned above.

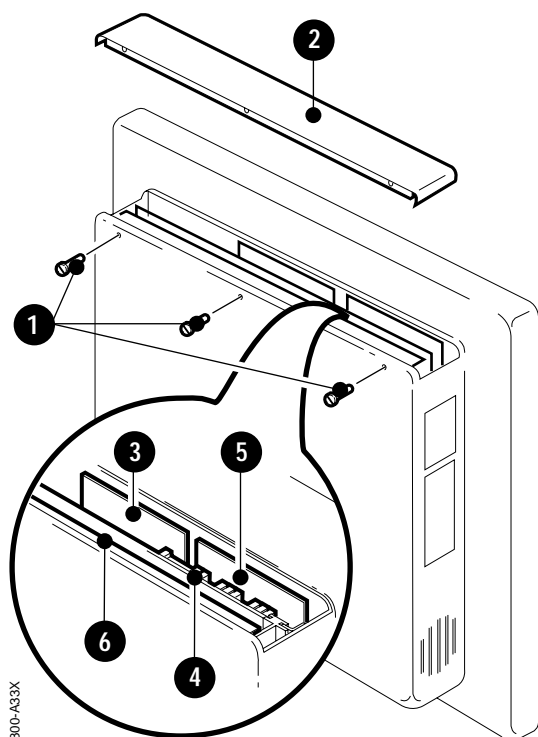
Mount the control knob with its pointer wings in horizontal position as shown in the illustration.

## Disassembling the control section

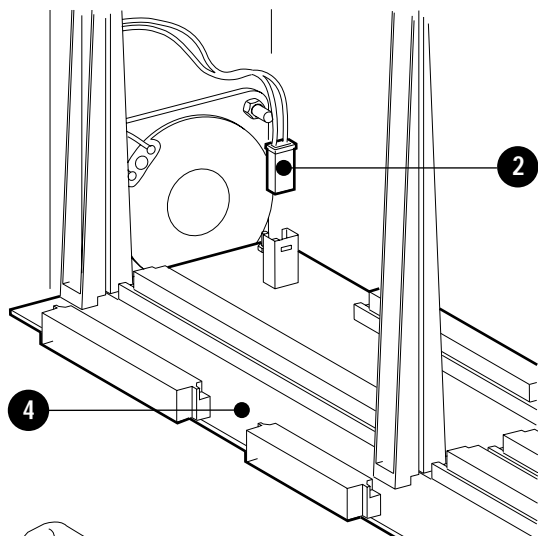
### PC boards PC 1587, PC 1605, PC 1608 and PC 1616

- Remove the screws (1) and lift off the control section lid (2).
- To remove any of the boards PC 1605 (3), PC 1608 (4) or PC 1616 (5), grasp the PC board and pull it out.
- To remove PC 1587 (6), first remove PC 1608 as mentioned above. When PC 1608 is removed, grasp PC 1587 and pull it out.

**Note** – Before exchanging COM-PROMs on PC 1587, always disconnect the power supply from the battery on PC 1587. See information regarding power supply disconnection in chapter "4. Service procedures", section "[Resetting the trend data memory and real time clock](#)".

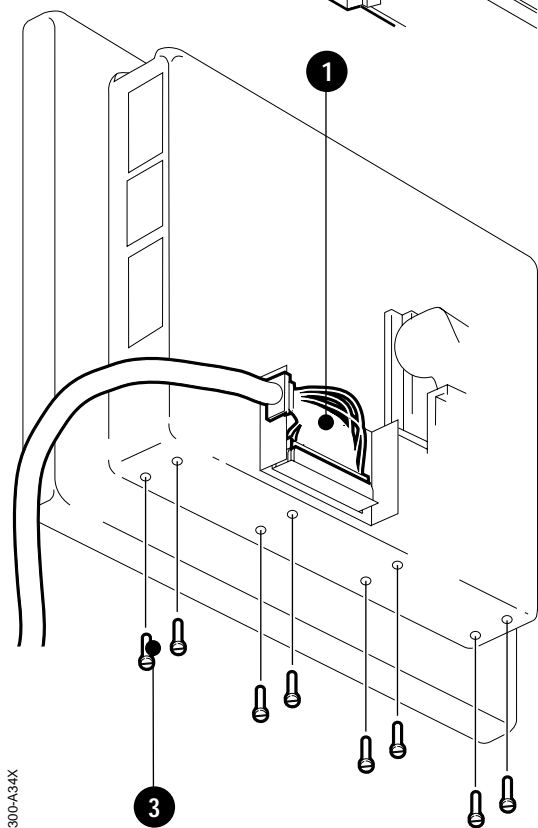


## Control interconnection board PC 1617



- Separate the panel section from the control section as previously described.
- Remove PC boards PC 1587, PC 1605, PC 1608 and PC 1616 as previously described.
- Disconnect the two interconnection cable connectors (1) from the control unit. See section "Removing the interconnection cable".
- Disconnect the loudspeaker connector (2).
- Remove the screws (3) and lift off PC 1617 (4).

3



300-A34X

## Assembling the control section

The procedure for assembling the control section is the reverse of the disassembly procedure previously performed.

The following points must be noted during assembling:

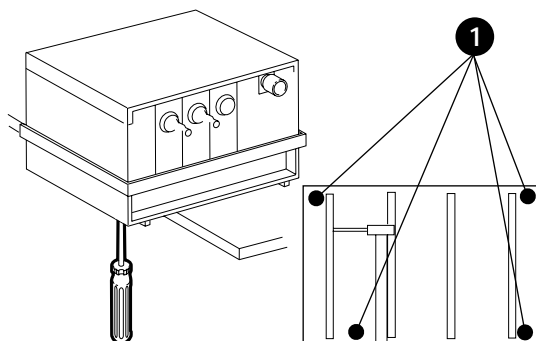
### PC boards

- The PC boards are mounted in different types of guides. Make sure that the PC boards are correctly supported by these guides.
- The PC board connectors on the control interconnection board PC 1617 are not symmetrically mounted. The connectors can be damaged if a PC board is mounted in wrong position.

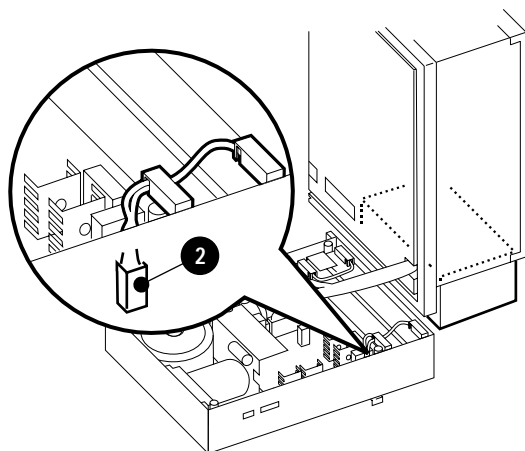
## Assembling the panel section to the control section

The procedure for assembling the panel section to the control section is the reverse of the separating procedure previously performed.

## Separating the pneumatic section from the power section

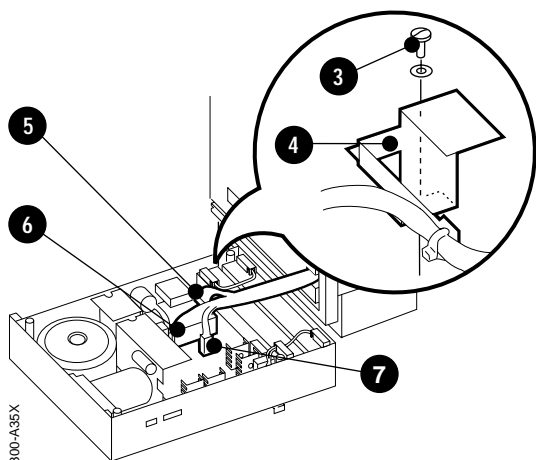


- Place the patient unit on the edge of the workbench so the screws are accessible from below.
- Loosen the four screws (1).



- Lift off the pneumatic section from the power section. Place the pneumatic section on a support beside the power section.
- Disconnect the battery connector (2).

To reduce the risk of damages, caused by short-circuits in the power section, always have the batteries disconnected when the power section is open.

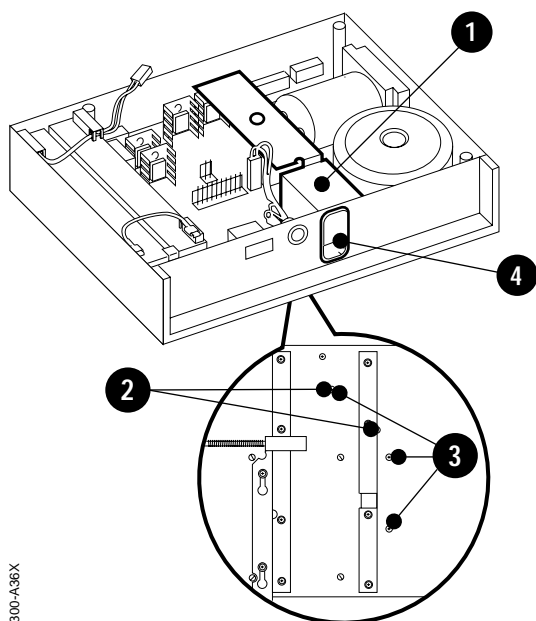


- Instead of cutting the cable ties, remove the screw (3) holding the battery bracket (4).
- Disconnect the connectors (5, 6 and 7).

The pneumatic section is now separated from the power section.

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3



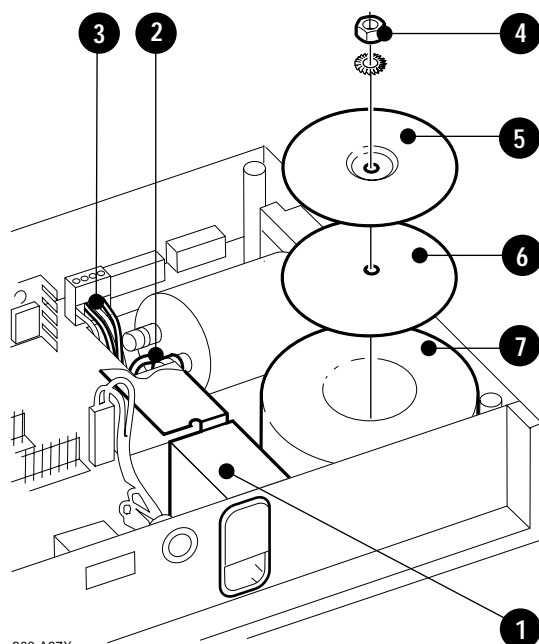
300-A36X

## Disassembling the power section

### Mains power inlet

- Separate the pneumatic section from the power section as previously described.
- Remove the cover (1).  
On older units: A small plastic cover mounted with two screws (2).  
On newer units: A big metal cover (as illustrated) mounted with three screws (3). An EMI-filter is attached to the cover with a cable tie. Cut the cable tie if the cover must be completely removed from the power section.
- Disconnect the cables from the mains power inlet.
- Remove the mains power inlet (4) from the power section.

### Transformer

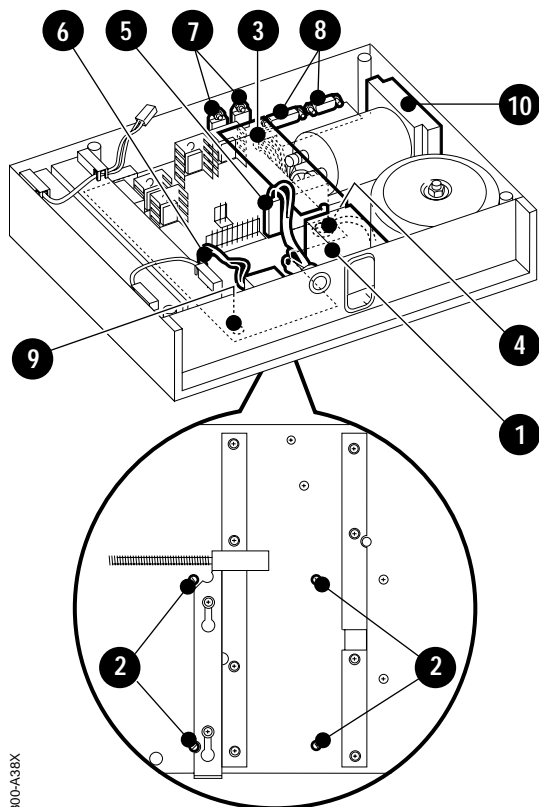


300-A37X

- Separate the pneumatic section from the power section as previously described.
- Remove the cover (1) from the mains power inlet as previously described.
- Disconnect the transformer cables from the mains power inlet.
- Disconnect the transformer cables from the capacitor (2) and from the screw terminal (3).
- Remove the nut (4), washer (5) and rubber plate (6).
- Lift off the transformer (7).



## Power supply board PC 1618

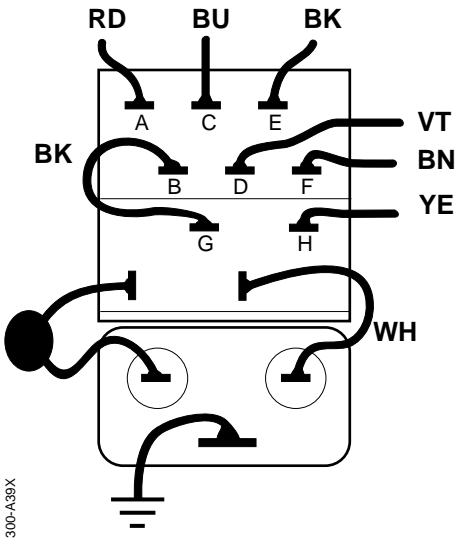


- Separate the pneumatic section from the power section as previously described.
- Remove the cover (1) from the mains power inlet.
- Remove the four screws (2).
- Disconnect the;
  - Cables at screw terminal (3).
  - Ground cable (4). This ground cable is used only in older versions. It has been removed in newer versions.
  - External battery inlet connector (5).
  - Operating time meter connector (6).
- Remove the nuts holding the diodes (7) and release the diodes from the screws.
- Remove the nuts and screws holding the two auxiliary equipment outputs (8).
- Remove the screw (9).
- Remove the capacitor holder (10).
- Carefully lift off the PC 1618.

3

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3



### Assembling the power section

The procedure for assembling the power section is the reverse of the disassembly procedure previously described.

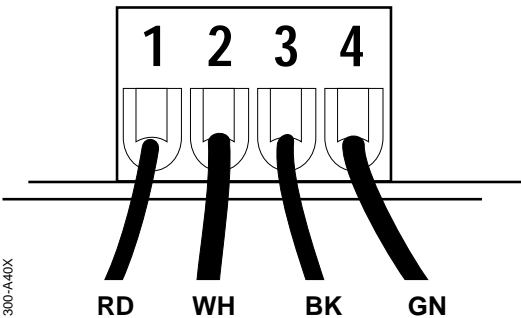
The following points must be noted during assembling:

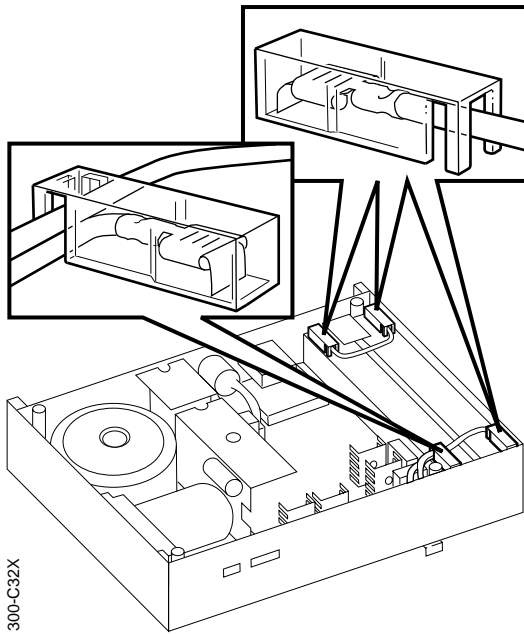
#### Mains power inlet

- Connect the cables to the mains power inlet according to figure.

#### Power supply board PC 1618

- Connect cables to screw terminal according to figure.





### Battery pole covers

- Make sure that the battery pole covers are mounted on the battery poles according to figure.

3

### Assembling the pneumatic section to the power section

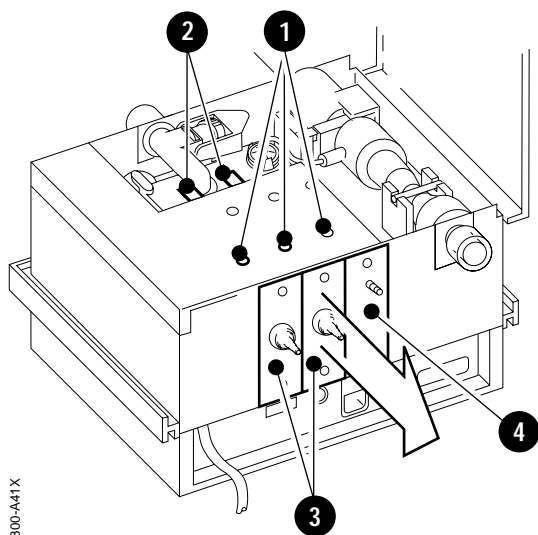
The procedure for assembling the pneumatic section to the power section is the reverse of the separating procedure previously performed.

## Disassembling the pneumatic section

### Inspiratory valves (gas modules)

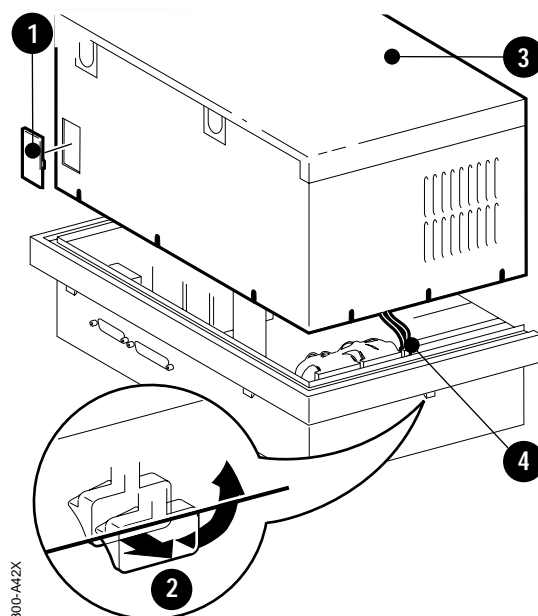
- Remove the screw (1).
- Push down the safety catch (2).
- Pull out the inspiratory valve (3).
- If the inspiratory valve unit – Optional (4) is replaced with units for SUN 345 or NO gas administration, these units must also be removed.

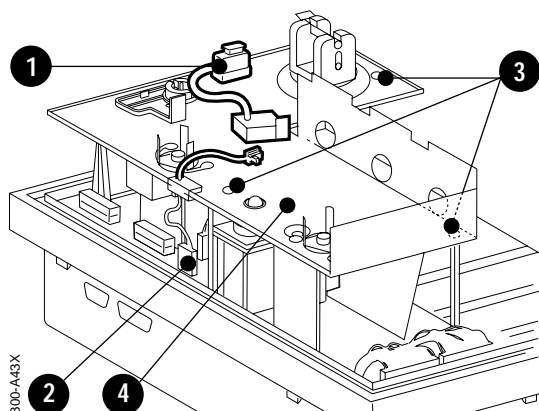
The inspiratory valves are factory calibrated. They must *not* be disassembled further than described in the Operating Manual, chapter "3000 hours overhaul with complete cleaning".



### Pneumatic section casing

- Remove the inspiratory and expiratory channels as described in the Operating Manual, chapter "3000-hours overhaul with complete cleaning".
- Remove the plastic cover (1). This cover is not included in newer units.
- Pull out and turn the locking pins (2) from the locked position.
- Lift the casing (3) carefully until the fan connector (4) is accessible.
- Disconnect the fan connector (4).
- Lift off the casing (3).

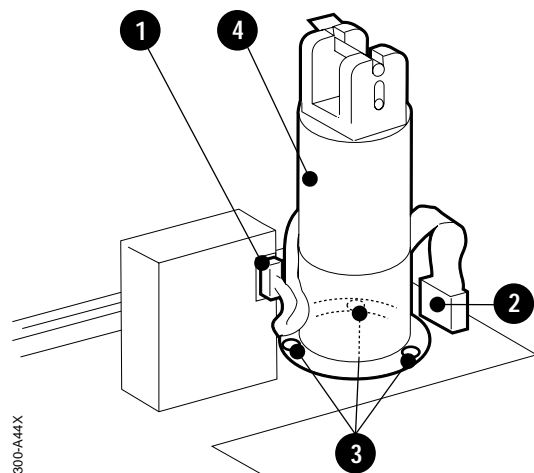




### Cover plate

- Remove the inspiratory valves for AIR and O<sub>2</sub> as previously described.
- Remove the pneumatic section casing as previously described.
- Disconnect the flow transducer cable (1).
- Disconnect the O<sub>2</sub> cell cable (2).
- Remove the three screws (3).
- Carefully lift off the cover plate (4).

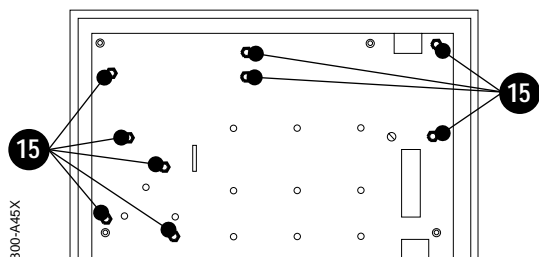
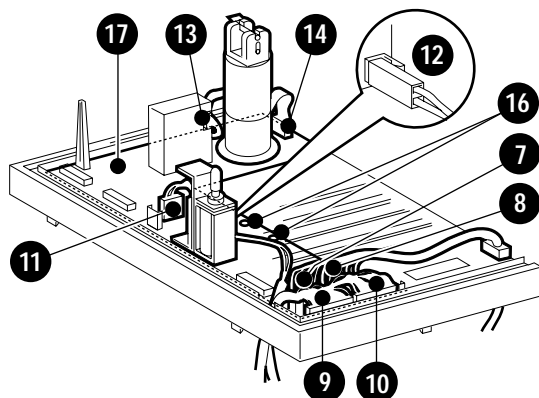
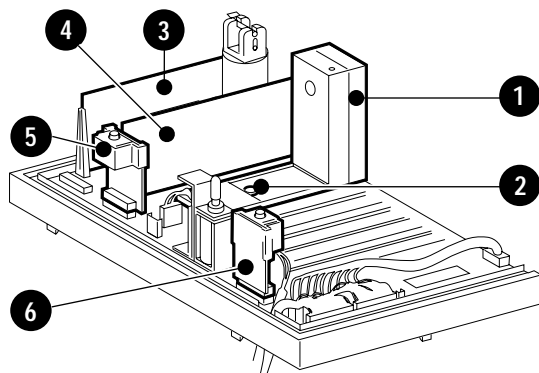
3



### Expiratory valve

- Remove the cover plate as previously described.
- Disconnect the two expiratory valve connectors (1 and 2).
- Remove the three screws (3).
- Lift off the expiratory valve (4).

3



## Pneumatic interconnection board PC 1607

- Separate the pneumatic section from the power section as previously described.
- Remove the cover plate as previously described.
- If an inspiratory valve – Optional (1) is mounted, loosen the screw (2) and remove the valve dummy.
- Remove:
  - PC 1615 (3).
  - PC 1622 (4).
  - PC 1611 – Exp. (5).
  - PC 1611 – Insp. (6).

If the pressure in a pressure transducer is raised abnormally, the transducer can be damaged. When handling the two pressure amplifier boards PC 1611, never raise the pressure in the transducers by covering the hole or squeezing the silicon rubber connection piece.

- Disconnect:
  - Interconnection cable connectors (7 – 8).
  - Power supply cable connectors (9 – 10).
  - Safety valve connectors (11 – 12).
  - Expiratory valve connectors (13 – 14).
- Remove the nine nuts (15).
- Remove the two screws (16).
- Carefully lift off PC 1607 (17).

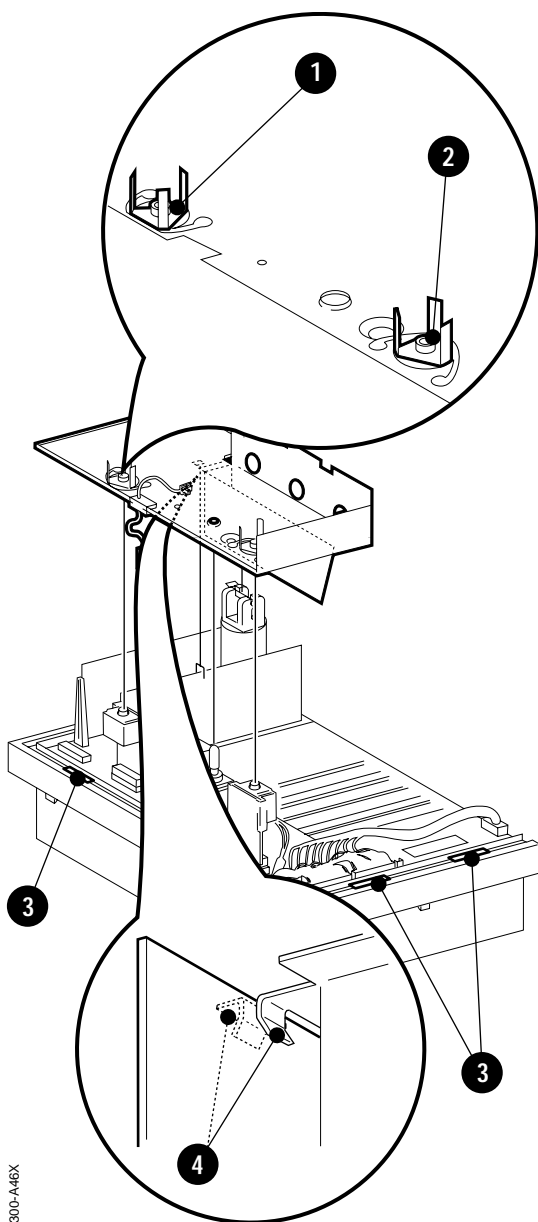
## Assembling the pneumatic section

The procedure for assembling the pneumatic section is the reverse of the disassembly procedure previously performed.

The following points must be noted during assembling:

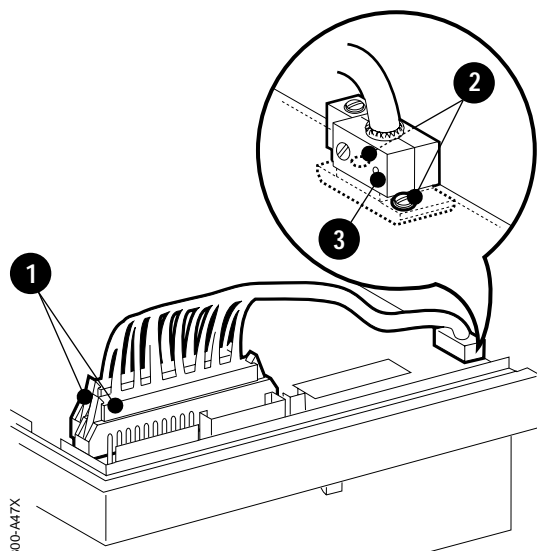
### Cover plate

- The silicon rubber connection pieces for the two pressure transducers must fit into the bacteria filter holders (1 and 2) on the cover plate.
- Make sure that all 8 ground springs (3) are in correct position between the pneumatic section and the power section when the sections are assembled.
- The cover plate is equipped with a guide for PC 1622. Make sure that the PC board is supported by this guide (4).



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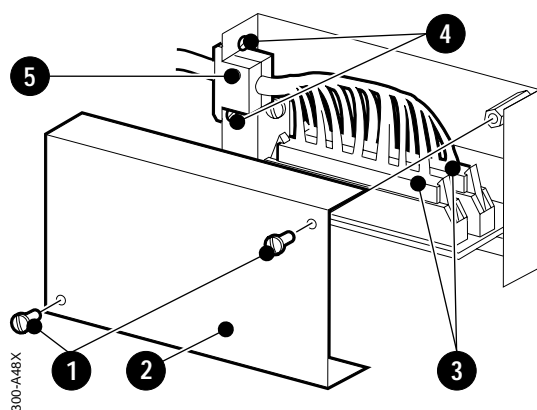
3



## Removing the inter-connection cable

### Patient unit connection

- Remove the pneumatic section casing as previously described.
- Disconnect the two interconnection cable connectors (1).
- Remove the two screws (2).
- Slide out the cable clamp (3) from the patient unit.



### Control unit connection

- Remove the two screws (1) and lift off the cover (2).
- Disconnect the two interconnection cable connectors (3).
- Remove the two screws (4).
- Slide out the cable clamp (5) from the control unit.

## Mounting the inter-connection cable

The procedure for assembling the inter-connection cable to the ventilator is the reverse of the removing procedure previously performed.

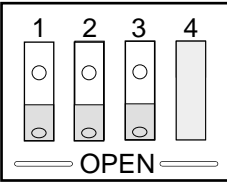


# 4. Service procedures

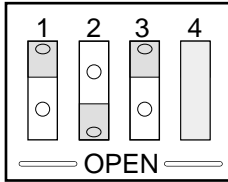
- Selecting the language and  
barometric pressure unit ..... 104
- Selecting the address code ..... 105
- Selecting the voltage setting ..... 105
- Replacing the fuses ..... 106
- Replacing the internal battery ..... 107
- Replacing the battery on  
PC 1587 Computer Interface ..... 108
- Resetting the trend data memory  
and real time clock ..... 108



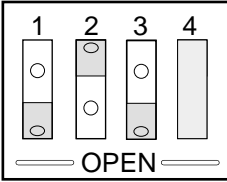
4



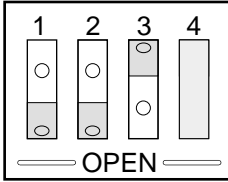
English



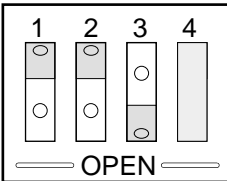
Spanish



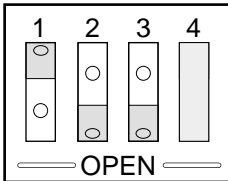
German



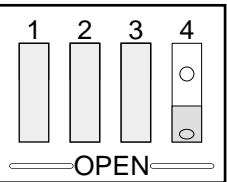
Italian



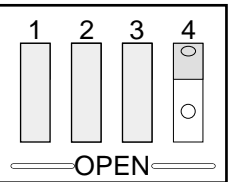
French



Swedish



mbar



mmHg

# Selecting the language and barometric pressure unit

The following selections are made with the switch SW1 on PC 1608 MONITORING:

- The language of the text shown in the "Alarms and messages" display.
- The unit of the actual barometric pressure shown in the "Alarms and messages" display.

PC 1608 must be removed from the control unit to make SW1 accessible. See also chapter "3. Disassembling and assembling" for detailed disassembling and assembling instructions.

- Disconnect and prepare the ventilator as described in chapter "3. Disassembling and assembling", section "Preparation".
- Remove PC 1608 from the control unit.

## Selecting the Alarms and messages language

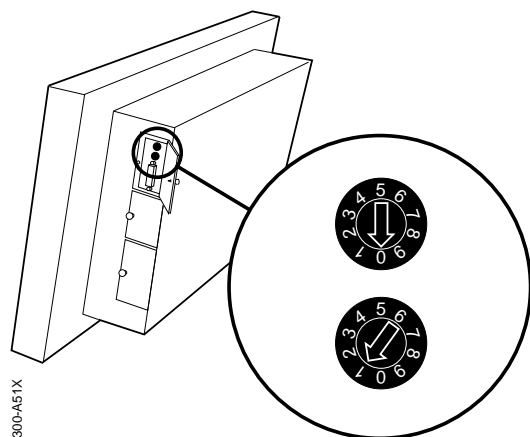
This illustration shows how the switches 1, 2 and 3 should be set to select the different available languages.

Switch settings not showed in this illustration will normally give english language.

## Selecting the barometric pressure unit

This illustration shows how the switch 4 should be set to select mmHg or mbar.

The actual barometric pressure is showed in the "Alarms and messages" display when the touch pads "Airway pressure" and "Technical" are touched simultaneously three times.

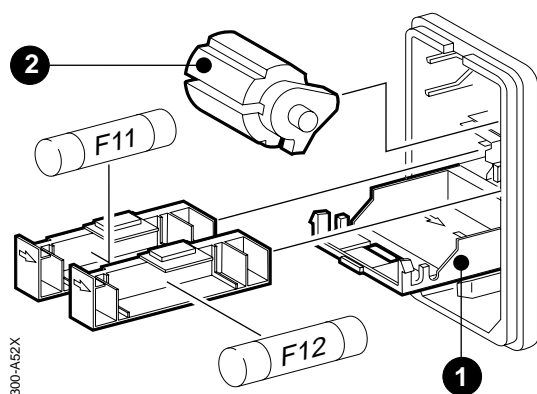


## Selecting the address code

The ventilators address code is selected with two switches SW1 and SW2 on PC 1587 COMPUTER INTERFACE.

The switches are located above SERIAL COMMUNICATION PORT 1 and they are accessible when the upper cover is opened.

The address code (device No.) can be selected between 00 and 99. The lower switch (SW2) sets the first digit and the upper switch (SW1) sets the second digit. The address code selected in the illustration is 10.



## Selecting the voltage setting

- Disconnect the mains power cable from the ventilator.
- Open the cover (1).
- Remove the drum (2), turn the drum to the selected voltage and put it back in this new position.

Mains power voltage	Selector setting
100 V ( $\pm 10\%$ )	100 V
120 V ( $\pm 10\%$ )	120 V
220 V ( $\pm 10\%$ )	220 V
230 V ( $\pm 10\%$ )	220 V (see note below)
240 V ( $\pm 10\%$ )	240 V

- Check that the fuses (F11 and F12) corresponds with the selected mains power voltage (see section "Replacing the fuses" in this chapter).
- Close the cover (1). The selected voltage is shown in the cover window.

**Note** – In many countries where the nominal mains power voltage is 230 V, the actual voltage is found to vary within a higher voltage range than specified for the selector setting 220 V. In such case, the selector setting for 240 V is recommended.

# Replacing the fuses

## Fuses F1, F2, F3 and F4

Fuses F1 – F4 are mounted on PC 1618 POWER SUPPLY inside the power section.

- Disconnect and prepare the ventilator as described in chapter "3. Disassembling and assembling", section "[Preparation](#)".
- Disassemble the power section as described in chapter "3. Disassembling and assembling", section "[Disassembling the power section](#)".
- Replace blown fuses with new fuses as listed in the table below:

Fuses	Purpose
F1: F 6.3 A	Limits the total +24 V supply current
F2: F 1.6 A	Controls the +24 V FUSED voltage
F3: F 6.3 A	Internal battery connector fuse
F4: F 6.3 A	External battery connector fuse

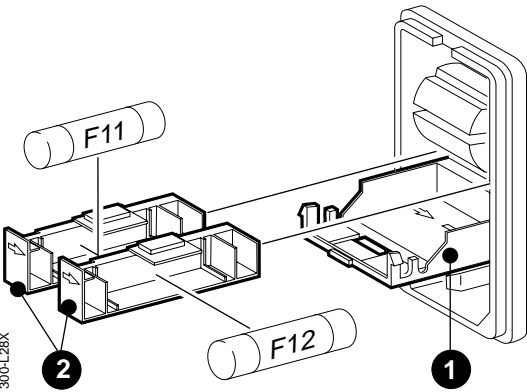
- Assemble the power section.

## Fuses F11 and F12

- Disconnect the mains power cable from the ventilator.
- Open the cover (1).
- Pull out the fuse holders (2).
- Replace blown fuses with new fuses as listed in the table below:

Mains power voltage	Selector setting	Fuses F11/F12
100 V (±10%)	100 V	T 3.15 AL
120 V (±10%)	120 V	T 3.15 AL
220 V (±10%)	220 V	T 1.6 AL
230 V (±10%)	220 V	T 1.6 AL
240 V (±10%)	240 V	T 1.6 AL

- Close the cover (1). The selected voltage is shown in the cover window.



## Replacing the internal battery

Normal service interval for exchange of the internal batteries is approx. 3 years.

The lifetime of the internal batteries are reduced if the batteries are used frequently to supply the ventilator with operating power. The batteries should not be recharged more than approx. 130 times to keep stated backup capacity.

The internal battery voltage level can be displayed in the "Alarm and Message" display on the front panel.

## Replacing the batteries

See also chapter "3. Disassembling and assembling" for detailed disassembling and assembling instructions.

- Disconnect and prepare the ventilator as described in chapter "3. Disassembling and assembling", section "Preparation".
- Lift off the pneumatic section from the power section.
- Remove the battery bracket.
- Replace the batteries. Both batteries must be replaced at the same time.
- Mount the battery bracket.
- Mount the battery pole covers.
- Assemble the pneumatic section to the power section.

After replacement, allow the batteries to recharge before clinical use of the ventilator.

Old non-functioning batteries must be returned to the place of purchase or to a place where they can be disposed of properly. Batteries must not be disposed of with ordinary waste.



## Replacing the battery on PC 1587 Computer Interface

Normal service interval for exchange of the battery is approx. 5 years.

The battery backs up the trend data memory and the real time clock when the SV 300 is switched off.

**Note** – When the battery is disconnected, all information stored in the trend data memory as well as time and date setting will be lost.

### Replacing the battery

See also chapter “[3. Disassembling and assembling](#)” for detailed disassembling and assembling instructions.

- Disconnect and prepare the ventilator as described in chapter “3. Disassembling and assembling”, section “[Preparation](#)”.
- Remove PC 1587 from the control unit.
- Replace the battery on PC 1587. Attach the new battery to the PC board with a cable tie.
- Assemble the control unit.
- Connect mains power and gas supply to the ventilator.
- Set the Mode selector to “Volume Control” (“Volume Control/Support” on SV 300A).
- Wait approx. 30 seconds and make sure that no “Technical error” information is shown in the “Alarm and messages” display.
- If the real time clock in SV 300 is used, set time and date. This can only be done by using e.g. a Servo Screen 390 connected to the port N82 on SV 300.

## Resetting the trend data memory and real time clock

The trend data memory and the real time clock in the SV 300 is used by e.g. a Servo Screen 390 connected to the SV 300.

**Note** – When resetting the memory, all information stored in the trend data memory as well as time and date setting will be lost.

### Resetting procedure

See also chapter “[3. Disassembling and assembling](#)” for detailed disassembling and assembling instructions.

- Disconnect and prepare the ventilator as described in chapter “3. Disassembling and assembling”, section “[Preparation](#)”.
- Make the battery on the upper part of PC 1587 accessible.
- Disconnect backup power supply to PC 1587 during at least 30 seconds by:
  - Disconnecting the battery cable at battery connector P1 *or*
  - Removing the jumper J1 located close to the battery connector.
 Both methods have the same effect.
- Connect the battery or jumper.
- Assemble the control unit.
- Connect mains power and gas supply to the ventilator.
- Set the Mode selector to “Volume Control” (“Volume Control/Support” on SV 300A).
- Wait approx. 30 seconds and make sure that no “Technical error” information is shown in the “Alarm and messages” display.
- Set time and date using e.g. a Servo Screen 390 connected to the port N82 on SV 300.

# 5.Troubleshooting

Troubleshooting table ..... 110



Before starting troubleshooting, try to eliminate all possibilities of operational errors. If the malfunction remains, use the troubleshooting table below as well as the information in chapter "2. Description of functions" to locate the faulty part. Perform actions step by step and check that the malfunction is eliminated.

When the fault is corrected, carry out a complete "Function check" as described in the Operating Manual.

All possible "Alarm and messages" texts and alarm conditions can be found in chapter "2. Description of functions", section "4. Monitoring".

The troubleshooting table below is focused only on alarm messages given for certain technical problems. Information about alarm messages for clinical problems can be found in the Operating Manual, chapter "Patient safety".

"Alarms and messages" text	Action
Technical error code PFT RESTART	Check/replace MON-PROM. Alarm is activated if MON-PROM V6.0 or higher is mounted on PC 1608D or lower. Replace PC 1608. Replace PC 1618 <sup>1</sup> .
Technical error code RAM RESTART	Replace PC 1588 on PC 1608. Replace PC 1608. Replace PC 1618 <sup>1</sup> .
Technical error code ROM RESTART	Replace PC 1588 on PC 1608. Replace PC 1608. Replace PC 1618 <sup>1</sup> .
Technical error code CPU RESTART	Replace PC 1588 on PC 1608. Replace PC 1618 <sup>1</sup> .
Technical error code $\mu$ P Pan SEE OPERATING MANUAL/ RESTART	Replace PC 1588 on PC 1614. Replace PAN-PROM. Replace PC 1614. Replace PC 1618 <sup>1</sup> .
Technical error code $\mu$ P SCM SEE OPERATING MANUAL/ RESTART	Replace PC 1587. Replace COM-PROM. Replace PC 1618 <sup>1</sup> .



<b>"Alarms and messages" text</b>	<b>Action</b>
Technical error code $\mu$ P R&T SEE OPERATING MANUAL/ RESTART	Replace PC 1588 on PC 1605. Replace REF-PROM. Replace PC 1605. Replace PC 1618 <sup>1</sup> .
Technical error code $\mu$ P Mix SEE OPERATING MANUAL/ RESTART	Replace PC 1588 on PC 1616. Replace MIX-PROM. Replace PC 1616. Replace PC 1618 <sup>1</sup> .
Technical error code $\mu$ P Exp SEE OPERATING MANUAL/ RESTART	Replace PC 1588 on PC 1615. Replace LIN-PROM. Replace PC 1615. Replace PC 1618 <sup>1</sup> .
Technical error code SwR SEE OPERATING MANUAL	Replace Patient range selector.
Technical error code SwM SEE OPERATING MANUAL	Replace Mode selector.
Technical error code PoC SEE OPERATING MANUAL	Replace CMV potentiometer.
Technical error code PoO SEE OPERATING MANUAL	Replace O <sub>2</sub> concentration potentiometer.
Technical error code Ba SEE OPERATING MANUAL	Replace PC 1608.
Technical error code PF SEE OPERATING MANUAL	Replace PC 1618. Replace PC 1608.
CHECK TUBINGS	Replace expiratory pressure Bacteria filter. Replace expiratory Pressure transducer.
High continuous pressure	Replace PC 1622. Replace Expiratory solenoid. Replace PC 1585 + PC 1586 (one unit).

<sup>1</sup> Multiple monitoring and uP errors can be an indication of power supply error.

## Notes

5

# 6. Product change history

PROM, PC board and  
Operating Manual versions ..... 114



# **PROM, PC board and Operating Manual versions**

Due to upgrades performed on delivered ventilators, the PROM, PC board and Operating Manual versions as listed below should be used with the Servo Ventilator 300/300A.

The list is valid August 1997. Possible future upgrades and product evaluations may change the configuration of the ventilator, i.e. PROMs, PC boards and Operating Manuals with higher version numbers are possible.

PROMs, PC boards and Operating Manuals with lower version numbers than stated in the list should not be used.

The difference between the Operating Manual versions can briefly be described as follows:

**Version 7.X** – Describes the functions of Servo Ventilator 300 with Failure Alarm Box (FAB).

**Version 8.X** – Describes the functions of Servo Ventilator 300 without Failure Alarm Box (FAB) and the FAB-functions incorporated on PC 1608E.

**Version 9.X** – Describes the functions of Servo Ventilator 300A. Must be used on ventilators with Automode.

Mandatory and optional upgrades:

**Upgrade 1995-09** (USA) – Mandatory.

**Upgrade 1995-10** (Rest of World) – Mandatory.

**Alarm system enhancement kit 96-05** – Optional.

**Automode upgrade** – Optional.

PROM	PC board	Operating Manual	Introduced
COM-PROM V2.01	PC 1587D	Version 7.X, 8.X, 9.X	1995. Upgrade 1995-09/1995-10
LIN-PROM V1.03	PC 1615A - E PC 1615F	Version 7.X, 8.X Version 7.X, 8.X, 9.X	1995. Upgrade 1995-09/1995-10 1996. Automode
MIX-PROM V4.02 MIX-PROM V4.04	PC 1616A - B PC 1616B (rev 05)	Version 7.X, 8.X, 9.X Version 8.X, 9.X (+NO)	1995. Upgrade 1995-09/1995-10 1997. NO
MON-PROM V5.01 MON-PROM V6.00 MON-PROM V6.01 MON-PROM V6.02	PC 1608A - E PC 1608E PC 1608E PC 1608E (rev. 14)	Version 7.X Version 8.X Version 8.X, 9.X Version 8.X, 9.X (+NO)	1995. Upgrade 1995-09/1995-10 1996. Alarm system Enhan. kit 96-05 1996. Automode 1997. NO
PAN-PROM V4.04 PAN-PROM V4.05 PAN-PROM V4.08	PC 1614A - F PC 1614A - F PC 1614A - F	Version 7.X, 8.X Version 7.X, 8.X, 9.X Version 8.X, 9.X (+NO)	1995. Upgrade 1995-09/1995-10 1996. Automode 1997. NO
REF-PROM V1.01 REF-PROM V2.02	PC 1605A - E PC 1605A - E	Version 7.X, 8.X Version 7.X, 8.X, 9.X	1995. Upgrade 1995-09/1995-10 1996. Automode

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Functions	Included in	PC board	Introduction	Description of functions	Disassembling and assembling	Service procedures	Product change history
<b>A</b>							
A/D, D/A	Computer interface	PC 1587	–	31	–	–	–
Address code	Computer interface	PC 1587	–	–	–	105	–
Air inlet	Inspiratory valve unit – Air	–	–	62	–	–	–
Air inlet with dust filter	Cooling system	–	–	76	–	–	–
Airway pressure	Front panel	–	–	26	–	–	–
Alarms and messages	Front panel	–	–	27	–	104	–
Analog I/O terminal	Computer interface	PC 1587	–	31	90	–	–
Analog input & Digital code port	Computer interface	PC 1587	–	32	–	–	–
Automode function	Reference & Timing	PC 1605	–	58	–	–	114
Automode front panel	Front panel	–	–	27	87	–	–
Automode panel interface	Panel interface	PC 1745	9	29	–	–	–
Auxiliary outputs	Power supply	PC 1618	11	77	95	–	–
<b>B</b>							
Backup alarm system	Monitoring	PC 1608	–	45	–	–	–
Bacteria filter (Exp.)	Expiratory pressure	–	–	71	–	–	–
Bacteria filter (Insp.)	Inspiratory pressure	–	–	70	–	–	–
Bacteria filter (Insp. valve)	Inspiratory valve unit – Air	–	–	62	–	–	–
Barometer pressure transducer	Monitoring	PC 1608	–	48	–	–	–
Barometric pressure unit	–	–	–	–	–	104	–
Basic principles	–	–	12	–	–	–	–
Battery	Computer interface	PC 1587	–	31	–	108	–
Beeper	Monitoring	PC 1608	–	48	–	–	–
<b>C</b>							
Capacitor	Mains power	–	11	76	95	–	–
Charge control	Power supply	PC 1618	–	79	–	–	–
Compensation ±5%	Inspiratory valve unit – Air	PC 1600	–	65	–	–	–
Computer interface	–	PC 1587	10	30	90	108	114
Computer interface dummy	–	PC 1665	10	33	90	–	–
Control interconnection	Control unit	PC 1617	9	–	91	–	–
Control section	Control unit	–	9	30	90	–	–
Control unit	–	–	9	25	86	–	–
Cooling fan	Cooling system	–	–	76	–	–	–
Cooling system	Patient unit	–	–	76	–	–	–
Current control (Exp.)	Expiratory valve	PC 1585	11	74	–	–	–
Current control (Insp.)	Inspiratory valve unit – Air	PC 1585	–	65	–	–	–
Current power (Exp.)	Expiratory valve	PC 1586	11	74	–	–	–
Current power (Insp.)	Inspiratory valve unit – Air	PC 1586	–	65	–	–	–

Functions	Included in	PC board	Introduction	Description of functions	Disassembling and assembling	Service procedures	Product change history
<b>D</b>							
Delta pressure amplifier	Inspiratory valve unit – Air	PC 1602	–	64	–	–	–
Delta pressure transducer and net	Inspiratory valve unit – Air	–	–	63	–	–	–
<b>E</b>							
End inspiration indicator	Reference & Timing	PC 1605	–	60	–	–	–
Expiratory channel	–	–	10	71	–	–	–
Expiratory connection tube	Expiratory channel	–	–	71	–	–	–
Expiratory flow linearization	–	PC 1615	11	75	–	–	114
Expiratory flow amplifier	Expiratory channel	PC 1623	–	72	–	–	–
Expiratory flow linearizer	Expiratory flow linearization	PC 1615	–	75	–	–	–
Expiratory flow transducer	Expiratory channel	–	–	71	–	–	–
Expiratory inlet with moisture trap	Expiratory channel	–	–	71	–	–	–
Expiratory outlet with non return valve	Expiratory channel	–	–	72	–	–	–
Expiratory pressure	Pneumatic section	–	–	71	–	–	–
Expiratory solenoid with position sensor	Expiratory valve	–	–	71	99	–	–
Expiratory valve tube	Expiratory channel	–	–	72	–	–	–
Expiratory valve	–	–	11	74	99	–	–
External battery inlet	Operating power	–	11	79	95	–	–
<b>F</b>							
Failure alarm box	Monitoring	–	–	48	–	–	114
Flow calculator	Inspiratory valve unit – Air	PC 1602	–	65	–	–	–
Flow filters & Integrators	Monitoring	PC 1608	–	45	–	–	–
Flow I control	Inspiratory valve unit – Air	PC 1600	–	65	–	–	–
Flow PI control	Inspiratory valve unit – Air	PC 1601	–	65	–	–	–
Front panel	–	–	–	25	87	–	–
Fuses	–	–	–	–	–	106	–
<b>G</b>							
Gas composition compensation	Expiratory flow linearization	PC 1615	–	75	–	–	–
Grounding terminal	Operating power	–	–	80	–	–	–
<b>I</b>							
I/O buffers	Computer interface	PC 1587	–	31	–	–	–
I/O	Reference & Timing	PC 1605	–	60	–	–	–
Inputs (Insp. control)	Inspiratory control	PC 1616	–	61	–	–	–
Inputs (Panel interface)	Panel interface	PC 1614	–	28	–	–	–

Functions	Included in	PC board	Introduction	Description of functions	Disassembling and assembling	Service procedures	Product change history
Inputs interface & A/D	Monitoring	PC 1608	–	45	–	–	–
Inspiratory channel	–	–	10	68	–	–	–
Inspiratory control	–	PC 1616	10	61	90	–	114
Inspiratory mixing part	Inspiratory channel	–	–	68	–	–	–
Inspiratory pipe	Inspiratory channel	–	–	68	–	–	–
Inspiratory pressure	–	–	–	70	–	–	–
Inspiratory solenoid	–	–	–	–	–	–	–
with position sensor	Inspiratory valve unit – Air	–	–	63	–	–	–
Inspiratory valve key	Inspiratory valve unit – Air	–	–	63	–	–	–
Inspiratory valve	–	–	–	–	–	–	–
temperature sensor	Inspiratory valve unit – Air	PC 1637	–	63	–	–	–
Inspiratory valve unit – Air	–	–	10	62	98	–	–
Inspiratory valve unit – O <sub>2</sub>	–	–	10	67	98	–	–
Inspiratory valve unit – Optional	–	–	10	67	98	–	–
Interconnection cable	–	–	8	80	102	–	–
Internal battery	Operating power	–	11	79	93	107	–
<b>L</b>							
LED array	Panel interface	PC 1614	–	28	–	–	–
LED indicators	Computer interface	PC 1587	–	32	–	–	–
LED matrix	Panel interface	PC 1614	–	28	–	–	–
Linearizing CPU including	–	–	–	–	–	–	–
LIN-PROM functions	Expiratory flow linearization	PC 1615	–	75	85	–	114
Loudspeaker	Monitoring	PC 1608	–	48	91	–	–
<b>M</b>							
Mains power inlet	Mains power	–	11	76	95	–	–
Mains power	–	–	–	76	–	–	–
Master/Slave connection	Computer interface	PC 1587	–	31	–	–	–
Microprocessor CPU including	–	–	–	–	–	–	–
COM-PROM functions	Computer interface	PC 1587	–	31	85	–	114
Microprocessor module	–	PC 1588	–	23	84	–	–
Mixer	Inspiratory control	PC 1616	–	61	–	–	–
Mixer CPU including	–	–	–	–	–	–	–
MIX-PROM functions	Inspiratory control	PC 1616	–	61	85	–	114
Mode CPU including	–	–	–	–	–	–	–
REF-PROM functions	Reference & Timing	PC 1605	–	49	85	–	114
Mode select	Panel interface	PC 1614	–	28	–	–	–
Mode selection	Front panel	–	–	27	–	–	–



Functions	Included in	PC board	Introduction	Description of functions	Disassembling and assembling	Service procedures	Product change history
Monitor/Alarm CPU including MON-PROM functions	Monitoring	PC 1608	–	34	85	–	114
Monitoring	–	PC 1608	10	34	90	–	114
Monitor display	Panel interface	PC 1614	–	29	–	–	–
<b>N</b>							
Nozzle unit	Inspiratory valve unit – Air	–	–	63	–	–	–
<b>O</b>							
O <sub>2</sub> cell	Inspiratory channel	–	10	68	–	–	–
O <sub>2</sub> concentration amplifier	Valve control	PC 1622	–	73	–	–	–
O <sub>2</sub> concentration	Front panel	–	–	27	–	–	–
O <sub>2</sub> inlet	Inspiratory valve unit – O <sub>2</sub>	–	–	67	–	–	–
Operating power	–	–	–	79	–	–	–
Operating time meter	Operating power	–	11	80	94	–	–
Optional interface	–	–	–	74	–	–	–
Optional PC board slot	–	–	–	48	–	–	–
Opto switch	Panel interface	PC 1614	–	29	–	–	–
<b>P</b>							
Panel interface	–	PC 1614	9	28	87	–	114
Panel section	Control unit	–	9	25	86	–	–
Panel CPU including PAN-PROM functions	Panel interface	PC 1614	–	28	85	–	114
Panel display	Panel interface	PC 1614	–	28	–	–	–
Parameter buffers	Panel interface	PC 1614	–	28	–	–	–
Patient range selection	Front panel	–	–	25	–	–	–
Patient trigger	Reference & Timing	PC 1605	–	59	–	–	–
Patient unit	–	–	10	62	93	–	–
Pause hold	Front panel	–	–	27	–	–	–
PEEP PID control	Valve control	PC 1622	–	73	–	–	–
Pneumatic interconnection	Patient unit	PC 1607	11	–	100	–	–
Pneumatic section	Patient unit	–	10	62	98	–	–
Position PD control (Exp.)	Valve control	PC 1622	–	73	–	–	–
Position PD control (Insp.)	Inspiratory valve unit – Air	PC 1601	–	65	–	–	–
Power section	Patient unit	–	11	76	94	–	–
Power supply	–	PC 1618	11	77	95	–	–
Power temperature control	Power supply	PC 1618	–	79	–	–	–
Pressure amplifier (Exp.)	Expiratory pressure	PC 1611	11	71	–	–	–
Pressure amplifier (Insp.)	Inspiratory pressure	PC 1611	11	70	–	–	–

Functions	Included in	PC board	Introduction	Description of functions	Disassembling and assembling	Service procedures	Product change history
Pressure amplifier (Insp. valve)	Inspiratory valve unit – Air	PC 1601	–	64	–	–	–
Pressure calculator	Inspiratory valve unit – Air	PC 1601	–	64	–	–	–
Pressure PID control	Reference & Timing	PC 1605	–	60	–	–	–
Pressure transducer (Exp.)	Expiratory pressure	PC 1611	–	71	–	–	–
Pressure transducer (Insp.)	Inspiratory pressure	PC 1611	–	70	–	–	–
<b>R</b>							
Reference & Timing	–	PC 1605	10	49	90	–	114
Respiratory pattern	Front panel	–	–	26	–	–	–
<b>S</b>							
Safety valve driver	Inspiratory channel	PC 1613	–	69	–	–	–
Safety valve	Inspiratory channel	–	11	69	–	–	–
Serial communication ports	Computer interface	PC 1587	–	32	–	–	–
Sound & Alarm control	Monitoring	PC 1608	–	45	–	–	–
Supply pressure amplifier	Inspiratory valve unit – Air	PC 1602	–	64	–	–	–
Supply pressure transducer	Inspiratory valve unit – Air	–	–	63	–	–	–
<b>T</b>							
Transducer temperature control	Expiratory flow linearization	PC 1615	–	75	–	–	–
Transformer	Mains power	–	11	76	95	–	–
<b>V</b>							
Valve code transponder	Inspiratory valve unit – Air	PC 1600	–	63	–	–	–
Valve control	–	PC 1622	11	73	–	–	–
Valve enabling	Valve control	PC 1622	–	73	–	–	–
Valve position calculator	Inspiratory valve unit – Air	PC 1603	–	65	–	–	–
Valve zeroing	Valve control	PC 1622	–	73	–	–	–
Version labels	–	–	–	24	–	–	–
Voltage control & Timing	Power supply	PC 1618	–	78	–	–	–
Voltage distribution	Power supply	PC 1618	–	78	–	–	–
Voltage setting	–	–	–	–	–	105	–
Volume	Front panel	–	–	26	–	–	–
<b>Z</b>							
Zero offset (Exp.)	Expiratory flow linearization	PC 1615	–	75	–	–	–
Zero offset (Insp.)	Inspiratory valve unit – Air	PC 1602	–	64	–	–	–

## 8. Diagrams

- External battery inlet P67 ..... 122
- Auxiliary output N77 ..... 122
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- Analog input & Digital code port N84 .... 125
- Interconnection cable ..... 126
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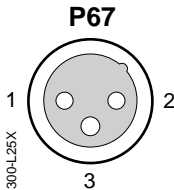
Only accessories, supplies or auxiliary equipment listed in Siemens-ElEMA catalogs ("Products and accessories" Order No. 90 34 562 E323E and "Spare and exchange parts" Order No. 90 34 570 E323E) must be connected to or used in conjunction with the ventilator.

**Warning:** Use of accessories and auxiliary equipment other than those specified in these catalogs may degrade safety and performance of the ventilator.

# External battery inlet P67

3-pole Cannon AXR connector (P67). Can be used to connect an external battery to the Servo Ventilator 300. Only Siemens connection cable must be used.

The illustration of the connector show outside view.



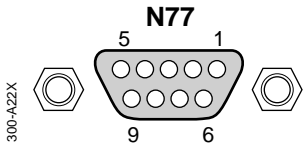
- 1 NC
- 2 +24 V (External battery pos.)
- 3 0 V (External battery neg.)

# Auxiliary output N77

9-pole D-sub connector (N77). Mainly used for power supply to auxiliary equipment. Only Siemens connection cable must be used.

The illustration of the connector show outside view.

If a signal has three different scale factor values, e. g. 3/3/18 V/l/s, the different values refers to selected front panel setting Adult/ Pediatric/Neonate.



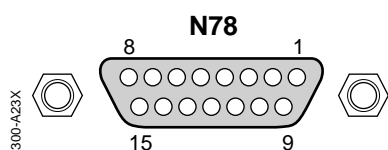
- 1 CGND
- 2 +24 V PO (Power Out)
- 3 Pow sup out 1 (not used, do not short-circuit)
- 4 Pow sup out 2 (not used, do not short-circuit)
- 5 CGND
- 6 EXP TIME H BUFF2, 0 V; 5 V
- 7 EXP PRESS BUFF2, 7.5 V/100 cm H<sub>2</sub>O
- 8 AIRWAY FLOW BUFF2, 3/3/18 V/l/s
- 9 ADULT RANGE L BUFF2, 0 V; 5 V

## Auxiliary output N78

15-pole D-sub connector (N78). Mainly used for power supply to auxiliary equipment. Only Siemens connection cable must be used.

The illustration of the connector show outside view.

If a signal has three different scale factor values, e. g. 3/3/18 V/l/s, the different values refers to selected front panel setting Adult/ Pediatric/Neonate.



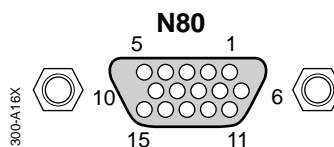
- 1 +24 V PO (Power Out)
- 2 +24 V PO (Power Out)
- 3 Pow sup out 1 (not used, do not short-circuit)
- 4 Pow sup out 2 (not used, do not short-circuit)
- 5 CGND
- 6 EXP TIME H BUFF2, 0 V; 5 V
- 7 CGND
- 8 CGND
- 9 +24 V PO (Power Out)
- 10 FAN CONTROL, Input
- 11 Pow sup out 3 (not used, do not short-circuit)
- 12 EXP PRESS BUFF2, 7.5 V/100 cm H<sub>2</sub>O
- 13 AIRWAY FLOW BUFF2, 3/3/18 V/l/s
- 14 ADULT RANGE L BUFF2, 0 V; 5 V
- 15 CGND

## Master/Slave connection N80

15 pole D-sub connector (N80). Can be used for the synchronization of two Servo Ventilator 300. Only Siemens connection cable must be used.

The illustration of the connector show outside view.

**Note** – If a voltage is connected to any of the pin number marked \* in the table below, the function of the ventilator can be influenced.



- 1 –
- 2\* Slave start exp H, 0 V; 5 V, Input
- 3\* Slave mode L, 0 V; 5 V, Input
- 4 Start exp buff H, 0 V; 5 V, Output
- 5 Clock buff 1 H, 0 V; 5 V, Output
- 6 –
- 7\* Slave start insp H, 0 V; 5 V, Input
- 8\* Slave clock H, 0 V; 5 V, Input
- 9 Start insp buff H, 0 V; 5 V, Output
- 10 Mode buff L, 0 V; 5 V, Output
- 11 GND, Input/Output reference
- 12 Pat trig buff H, 0 V; 5 V, Output
- 13\* Master pat trig H, 0 V; 5 V, Input
- 14 Mon dis insp valves master buff L, 0 V; 5 V, Output
- 15\* Mon dis insp valves slave L, 0 V; 5 V, Input

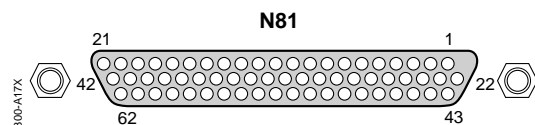
## Analog I/O terminal N81

62 pole D-sub connector (N81). Can be used for connection of monitoring/recording equipment. Only Siemens connection cable must be used.

The illustration of the connector show outside view.

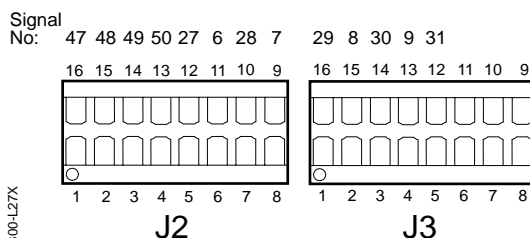
If a signal has three different scale factor values, e. g. 3/18/45 V/l/s, the different values refers to selected front panel setting Adult/Pediatric/Neonate.

Input control signals can be connected at N81 to control some ventilator functions (e.g. when using Bi-Phasic Ventilation). These input signals are routed via two sockets, J2 and J3, on PC 1587.



- |     |  |
|-----|--|
| 1   | Chassis GND  |
| 2   | V- limited; -15 V, max 200 mA, Output                    |
| 3   | 0 V (A), Input/Output reference                          |
| 4   | V+ limited; +15 V, max 200 mA, Output                    |
| 5   | -  |
| 6*  | Ext press contr lev set in, 0 V – +5 V, Input            |
| 7*  | Ext CMV freq set in, 0 V – +5 V, Input                   |
| 8*  | Ext SIMV freq set in, 0 V – +5 V, Input                  |
| 9*  | Ext insp time set in, 0 V – +5 V, Input                  |
| 10  | Neb flow buff 3 18 45, 3/18/45 V/l/s, Output             |
| 11  | Air flow buff 3 18 45, 3/18/45 V/l/s, Output             |
| 12  | Insp flow buff 3 3 18, 3/3/18 V/l/s, Output              |
| 13  | Exp flow buff 3 3 18, 3/3/18 V/l/s, Output               |
| 14  | Insp press buff 50 mV, 50 mV/cm H <sub>2</sub> O, Output |
| 15  | Exp press buff 50 mV, 50 mV/cm H <sub>2</sub> O, Output  |
| 16  | Internal battery voltage lim, Output                     |
| 17  | Insp time buff, 0V ; 5 V, Output                         |
| 18  | Range sel D0 buff, 0V ; 5 V, Output                      |
| 19  | Clock buff 2 H, 0V ; 5 V, Output                         |
| 20  | Patient trig buff H, 0V ; 5 V, Output                    |
| 21  | Serial data to slave buff H, 0V ; 5 V, Output            |
| 22  | GND, Input/Output reference                              |
| 23  | +5V limited; max 500 mA, Output                          |
| 24  | 0V (24), Input/Output reference                          |
| 25  | +24V limited; max 270 mA, Output                         |
| 26  | -  |
| 27* | Ext press supp lev set in, 0 V – +5 V, Input             |
| 28* | Ext insp rise time set in, 0 V – +5 V, Input             |
| 29* | Ext preset min vol set in, 0 V – +5 V, Input             |
| 30* | Ext pause time set in, 0 V – +5 V, Input                 |
| 31* | Ext CPAP flow set in, 0 V – +5 V, Input                  |

To enable the control functions, jumpers must be mounted in the sockets. The figure below, showing sockets J2 and J3, indicates which connectors that need to be short-circuited with a jumper to enable a control signal. (Signal No. as stated in the pin configuration list below.)



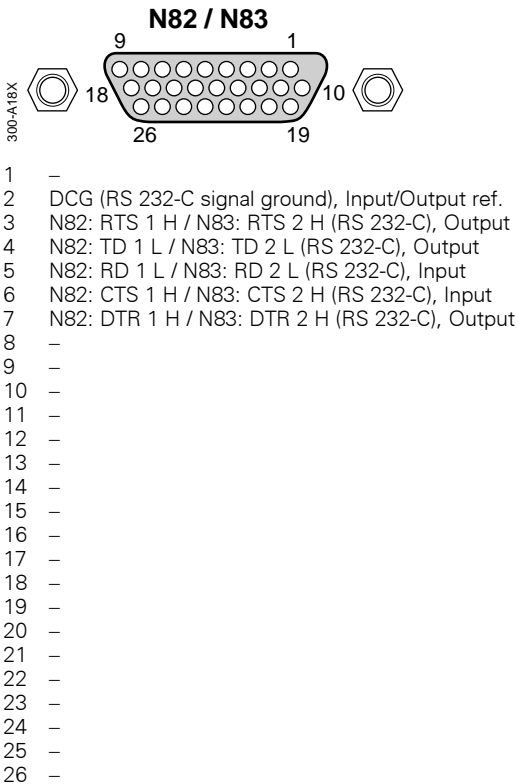
**Note** – If jumpers are mounted and a voltage is connected to any of the pin number marked \* in the table below, the function of the ventilator can be influenced.

- |     |   |
|-----|---|
| 32  | Airway flow buff 3 3 18, 3/3/18 V/l/s, Output                     |
| 33  | Barometric press buff 4.0, 4.0 V/Bar, Output                      |
| 34  | ET CO <sub>2</sub> conc buff 1.0, 1.0 V/%CO <sub>2</sub> , Output |
| 35  | O <sub>2</sub> flow buff 3 18 45, 3/18/45 V/l/s, Output           |
| 36  | Insp flow patient buff 3 3 18, 3/3/18 V/l/s, Output               |
| 37  | CO <sub>2</sub> conc buff 1.0, 1.0 V/%CO <sub>2</sub> , Output    |
| 38  | Serial data to master test H, 0V ; 5 V, Output                    |
| 39  | Range sel D1 buff, 0V ; 5 V, Output                               |
| 40  | Power up reset buff L, 0V ; 5 V, Output                           |
| 41  | Exp time buff, 0V ; 5 V, Output                                   |
| 42  | Alarm buff L, 0V ; 5 V, Output                                    |
| 43  | -   |
| 44  | -   |
| 45  | -   |
| 46  | -   |
| 47* | Ext O <sub>2</sub> conc set in, 0 V – +5 V, Input                 |
| 48* | Ext nebulizer time set in, 0 V – +5 V, Input                      |
| 49* | Ext trigg sens set in, 0 V – +5 V, Input                          |
| 50* | Ext PEEP lev set in, 0 V – +5 V, Input                            |
| 51  | Exp flow patient buff 3 3 18, 3/3/18 V/l/s, Output                |
| 52  | O <sub>2</sub> conc buff 90 mV, 90 mV/%O <sub>2</sub> , Output    |
| 53  | Insp flow patient buff 7.2 7.2 43.2, 7.2 7.2/43.2 V/l/s, Output   |
| 54  | Exp flow patient buff 7.2 7.2 43.2, 7.2 7.2/43.2 V/l/s, Output    |
| 55  | Insp press buff 10.7 mV, 10.7 mV/cm H <sub>2</sub> O, Output      |
| 56  | -   |
| 57  | -   |
| 58  | -   |
| 59  | Serial data to slave test H, 0 V ; 5 V, Input                     |
| 60  | Receive address test L, 0 V ; 5 V, Input                          |
| 61  | Control enable test H, 0 V ; 5 V, Input                           |
| 62  | Receive address buff L, 0V ; 5 V, Output                          |

Serial communication ports  
N82 and N83

26 pole D-sub connectors (N82 and N83). For RS-232-C data communication and for connection of monitoring/recording equipment. The connectors are identical with one exception; the internal clock can only be set via N82. Only Siemens connection cable must be used.

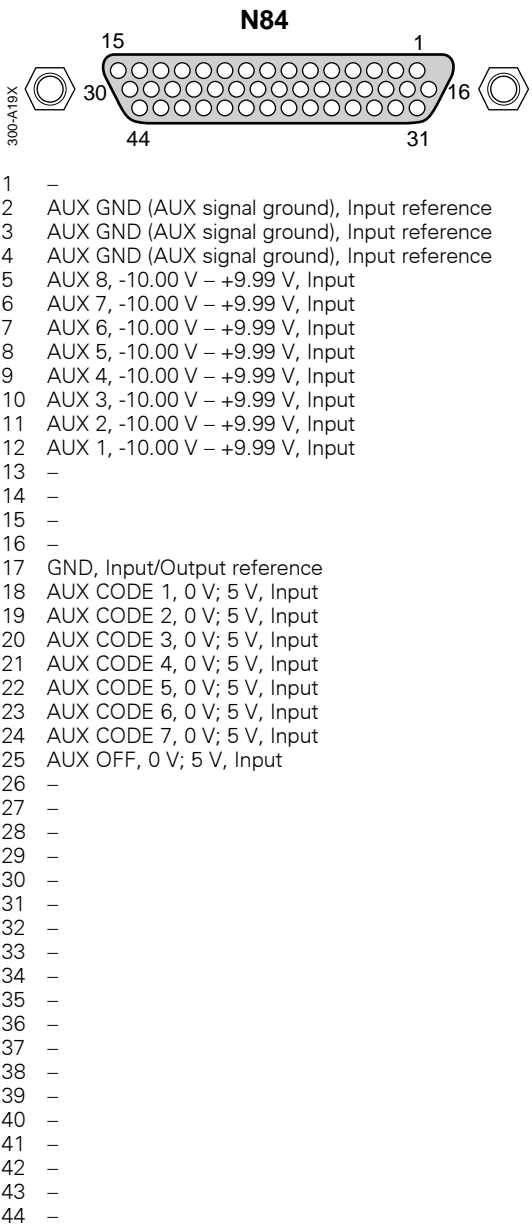
The illustration of the connector show outside view.



Analog input & Digital code  
port N84

44 pole D-sub connector (N84). Optional input interface. Only Siemens connection cable must be used.

The illustration of the connector show outside view.



## Interconnection cable

The INTERCONNECTION CABLE is the 2.95 m long 89 leads cable that connects the Control unit with the Patient unit. Signal names and pin numbers are listed below:

<b>Connected at patient unit N16</b>		<b>Connected at control unit N50</b>	
Pin No.	Signal name	Pin No.	
1	Dis Saf valve and 24 V L	1	
2	O <sub>2</sub> cell connected L	2	
3	–	3	
4	SF 6 conc	4	
5	CO <sub>2</sub> values	5	
6	ET CO <sub>2</sub> conc	6	
7	Insp flow	7	
8	CO <sub>2</sub> conc	8	
9	CO <sub>2</sub> trans connected	9	
10	Insp time H	10	
11	Receive address L	11	
12	Technical error CO <sub>2</sub> exp flow	12	
13	CPAP neonate mode H	13	
14	Serial data to slave H	14	
15	Exp detection H	15	
16	Serial data to master H	16	
17	Enable NEB valve H	17	
18	Enable O <sub>2</sub> valve H	18	
19	Enable AIR valve H	19	
20	Zeroing insp valves H	20	
21	Power up reset L	21	
22	Exp time H	22	
23	Mon dis insp valves L	23	
24	Ref dis insp valves L	24	
25	Reserve 2	25	
26	Exp flow	26	
27	Exp valve position	27	
28	Exp tidal volume	28	
29	Ext power overload	29	
30	Pow sup out 1	30	
31	Pow sup out 2	31	
32	Pow sup out 3	32	
33	Battery charging LED	33	
34	–	34	
35	Internal battery mode H	35	
36	Valve code clock H	36	
37	+24 V low power reg	37	
38	Load valve code L	38	
39	Ventilator on H	39	
40	Serial valve code 1 H	40	
41	Power on LED	41	
42	Range sel D0	42	
43	Adult range L	43	
44	Range sel D1	44	

### Connected at patient unit N15

### Connected at control unit N49

Pin No.	Signal name	Pin No.
1	+V	1
2	+V	2
3	GND	3
4	GND	4
5	GND	5
6	Sense GND	6
7	-V	7
8	-V	8
9	+5 VL	9
10	+5 V	10
11	+5 V	11
12	+5 V	12
13	+24 V	13
14	Sense +5 V	14
15	0 V (24)	15
16	0 VA	16
17	0 VA	17
18	0 VA	18
19	GNDL	19
20	Reserve 3	20
21	SGND	21
22	SGND	22
23	SGND	23
24	SGND	24
25	PS 4	25
26	–	26
27	Humidifier off L	27
28	Internal battery voltage	28
29	Power supply temp	29
30	External battery voltage	30
31	Inner shield (soldered)	–
32	–	32
33	Insp press	33
34	NEB flow ref	34
35	O <sub>2</sub> flow ref	35
36	AIR flow ref	36
37	NEB flow	37
38	O <sub>2</sub> flow	38
39	AIR flow	39
40	Valve position NEB	40
41	Exp press	41
42	Gas supply NEB press	42
43	O <sub>2</sub> conc	43
44	Valve position O <sub>2</sub>	44
45	PEEP level set buff	45
46	Gas supply O <sub>2</sub> press	46
47	Barometer press	47
48	Valve position AIR	48
49	Airway flow	49
50	Gas supply AIR press	50











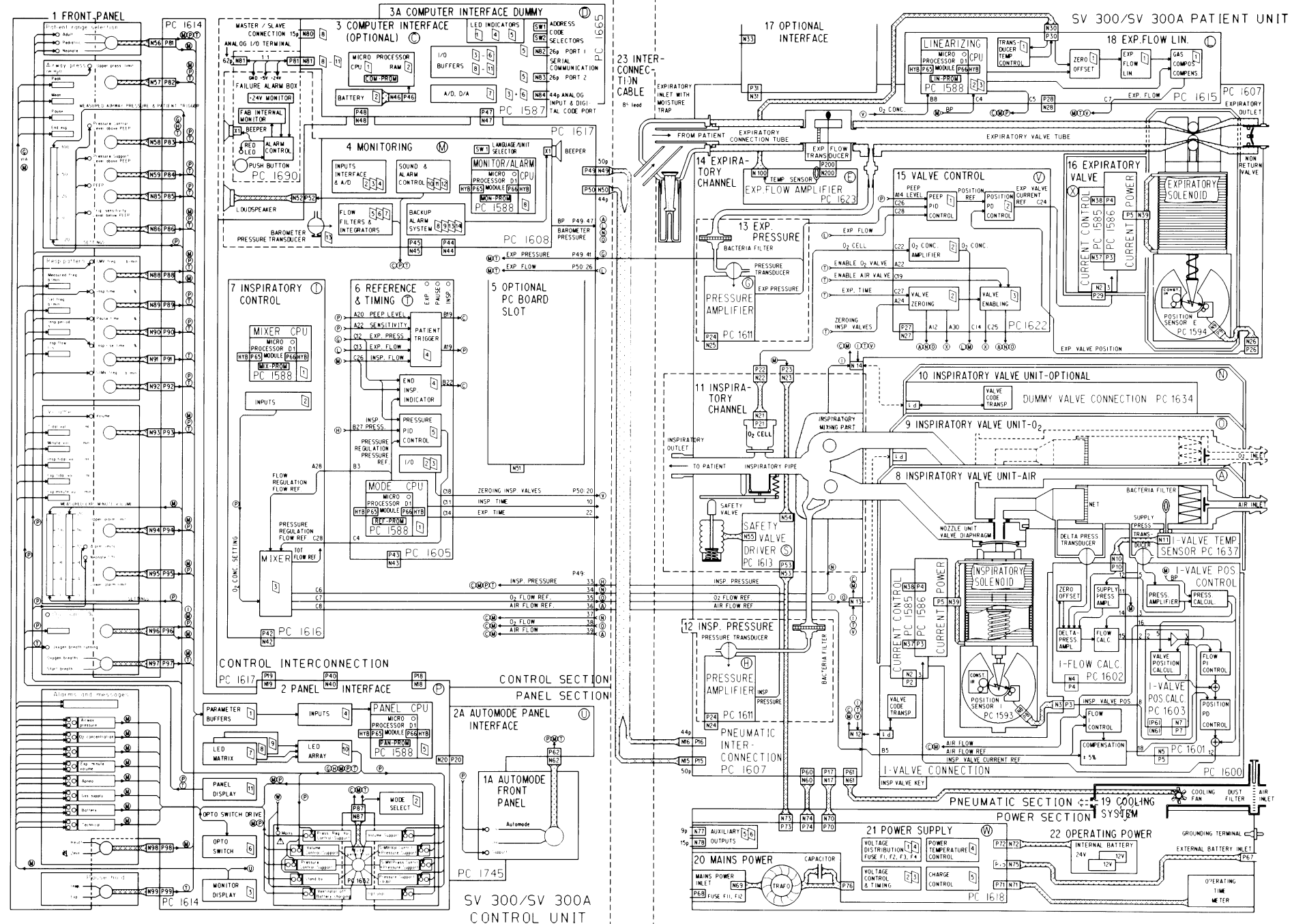
## Functional block diagram

Letter codes shown within a circle in the Functional block diagram

Code	Refers to block function	PC board No(s)
A	Inspiratory valve unit - <b>A</b> ir .....	PC 1585, 1586, 1593, 1600, 1601, 1602, 1603, 1637
B	-	
C	<b>C</b> omputer interface .....	PC 1587
D	Computer interface <b>D</b> ummy .....	PC 1665
E	<b>E</b> xp. flow amplifier .....	PC 1623
F	-	
G	Pressure amplifier - Exp. ....	PC 1611
H	Pressure amplifier - Insp. ....	PC 1611
I	<b>I</b> nspiratory control .....	PC 1616, 1588
J	-	
K	-	
L	Exp. flow <b>L</b> inearization .....	PC 1615, 1588
M	<b>M</b> onitoring .....	PC 1608, 1588 and with FAB: PC 1690
N	Inspiratory valve unit - Optional .	PC 1634 or other optional PC board
O	Inspiratory valve unit - <b>O</b> <sub>2</sub> .....	PC 1585, 1586, 1593, 1600, 1601, 1602, 1603, 1637
P	<b>P</b> anel interface .....	PC 1614, 1588, 1632
Q	-	
R	-	
S	<b>S</b> afety valve driver .....	PC 1613
T	Reference & <b>T</b> iming .....	PC 1605, 1588
U	<b>A</b> utomode panel interface .....	PC 1745
V	<b>V</b> alve control .....	PC 1622
W	<b>P</b> ower supply .....	PC 1618
X	<b>E</b> xpiratory valve .....	PC 1585, 1586

## Signs and interpretations

Signs	Interpretations
	Information coming from <b>M</b> onitoring
	Information going to <b>I</b> nspiratory control
	Guide to Circuit Diagram sheet number
	Internal male connector number
	Internal female connector number
	Internal connector pin number
	Internal signal path(s) (2 paths in example)
	Internal cable with connector



Servo Ventilator 300/300A – Service Manual  
Order No.: 60 26 905 E380E

E382 E380E 061 01 03 02

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